EXHIBIT B

Exhibit A-20
Invalidity Claim Chart for U.S. Patent No. 7,924,802 vs. U.S. Patent No. 7,742,388

U.S. Patent No. 7,742,388 ("Shearer") was filed on July 20, 2005, published on January 26, 2006 (U.S. Patent Application Publication No. 2006/0018249), and issued on June 22, 2010. Shearer anticipates asserted claims 1–4, 6–10, 13, 14, 17, and 21–24 of U.S. Patent No. 7,924,802 ("the '802 Patent") under 35 U.S.C. § 102. Shearer also renders obvious asserted claims 1–4, 6–10, 13, 14, 17, and 21–24 of the '802 Patent under 35 U.S.C. § 103, alone based on the state of the art and/or in combination with one or more other references identified in Exs. A-1–A-31, Cover Pleading, and First Supplemental Ex. A-Obviousness Chart.[1]

To the extent Plaintiff alleges that Shearer does not disclose any particular limitation of the asserted claims in the '802 Patent, either expressly or inherently, it would have been obvious to a person of ordinary skill in the art as of the priority date of the '802 Patent to modify Shearer and/or to combine the teachings of Shearer with other prior art references, including but not limited to the present prior art references found in Exs. A-1–A-31, Cover Pleading, First Supplemental Ex. A-Obviousness Chart, and the relevant section of charts for other prior art for the '802 Patent in a manner that would render the asserted claims of these patents invalid as obvious.

With respect to the obviousness of the asserted claims of the '802 Patent under 35 U.S.C. § 103, one or more of the principles enumerated by the United States Supreme Court in *KSR v. Teleflex*, 550 U.S. 398 (2007) apply, including: (a) combining various claimed elements known in the prior art according to known methods to yield a predictable result; and/or (b) making a simple substitution of one or more known elements for another to obtain a predictable result; and/or (c) using a known technique to improve a similar device or method in the same way; and/or (d) applying a known technique to a known device or method ready for improvement to yield a predictable result; and/or (e) choosing from a finite number of identified, predictable solutions with a reasonable expectation of success or, in other words, the solution was one which was "obvious to try"; and/or (f) a known work in one field of endeavor prompting variations of it for use either in the same field or a different field based on given design incentives or other market forces in which the variations were predictable to one of ordinary skill in the art; and/or (g) a teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill in the art to modify the prior art reference or to combine the teachings of various prior art references to arrive at the claimed invention. It therefore would have been obvious to one of ordinary skill in the art to combine the disclosures of these references in accordance with the principles and rationales set forth above.

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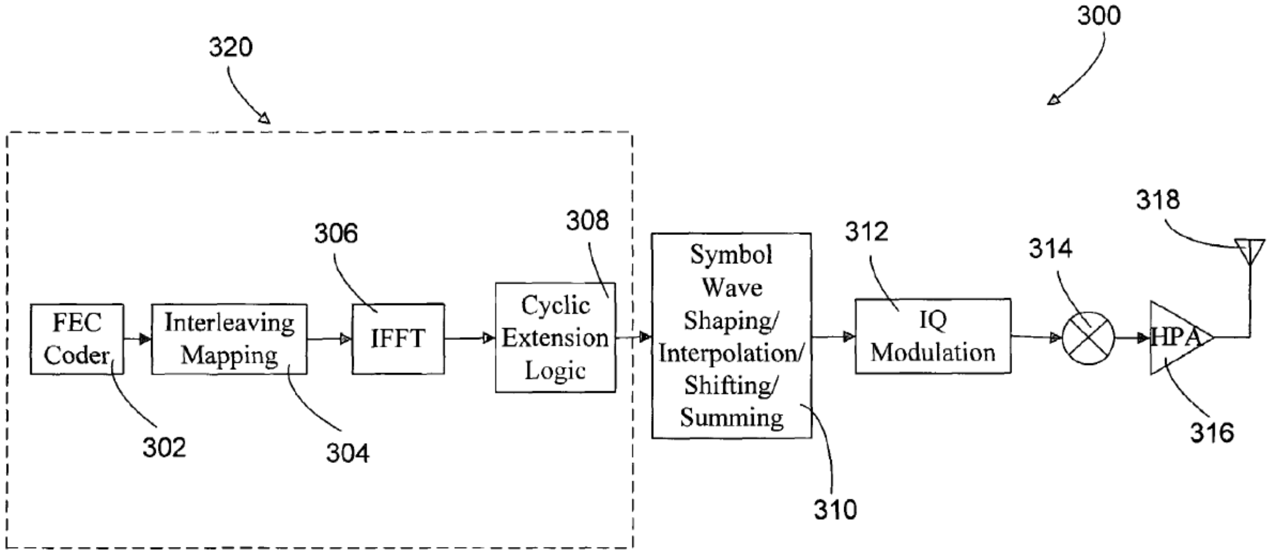
[1] Samsung is investigating this prior art and has not yet completed discovery from third parties, who may have relevant information concerning the prior art, and therefore, Samsung reserves the right to supplement this chart after additional discovery is received. To the extent that any of the prior art discloses the same or similar functionality or feature(s) of any of the accused products, Samsung reserves the right to argue that said feature or functionality does not practice any limitation of any of the asserted claims, and to argue, in the alternative, that if said feature or functionality is found to practice any limitation of any of the asserted claims in the '802 Patent, then the prior art reference teaches the limitation and that the claim is not patentable.

The citations to portions of any reference in this chart are exemplary only. For example, a citation that refers to or discusses a figure or figure item should be understood to also incorporate by reference that figure and any additional descriptions of that figure as if set forth fully therein. Samsung reserves the right to rely on the entirety of the references cited in this chart to show that the asserted claims of the '802 Patent are invalid. Citations presented for one claim limitation are expressly incorporated by reference into all other limitations for that claim as well as all limitations of all claims on which that claim depends. Samsung also reserves the right to rely on additional citations or sources of evidence that also may be applicable, or that may become applicable in light of claim construction, changes in Plaintiff's infringement contentions, and/or information obtained during discovery as the case progresses.

Claim 1 of the '802 Patent	Prior Art Reference – Shearer
[1.1] A method of transmitting information in a wireless communication channel comprising:	To the extent the preamble is limiting, Shearer discloses "A method of transmitting information in a wireless communication channel comprising." See, e.g.: Disclosed herein are various embodiments of methods, systems, and apparatus for increasing packet generation in a digital communication system. In one exemplary method embodiment, subcarriers are added to a packet in a wireless local area network transmission to increase the data rate. *See, e.g.*, Shearer at Abstract. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. *See, e.g.*, Shearer at 1:31-38. 802.11 is directed to wireless LANs, and in particular specifies the MAC and the PHY layers. These layers are intended to correspond closely to the two lowest layers of a system based on the ISO Basic Reference Model of OSI, i.e., the data link layer and the physical layer. FIG. 1 shows a diagrammatic representation of an open systems interconnection (OSI) layered model 100 developed by the

Claim 1 of the ’802 Patent	**Prior Art Reference – Shearer**
	International Organization for Standards (ISO) for describing the exchange of information between layers in communication networks. The OSI layered model 100 is particularly useful for separating the technological functions of each layer, and thereby facilitating the modification or update of a given layer without detrimentally impacting on the functions of neighboring layers. *See*, *e.g.*, Shearer at 3:61-4:7. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. *See*, *e.g.*, Shearer at 4:62-5:4. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[1.2] transmitting first information across a first frequency range using a wireless transmitter, the first frequency range having a first center frequency, a first	Shearer discloses “transmitting first information across a first frequency range using a wireless transmitter, the first frequency range having a first center frequency, a first highest frequency, and a first lowest frequency.” See, e.g.:

Claim 1 of the '802 Patent	Prior Art Reference – Shearer
highest frequency, and a first lowest frequency; and	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

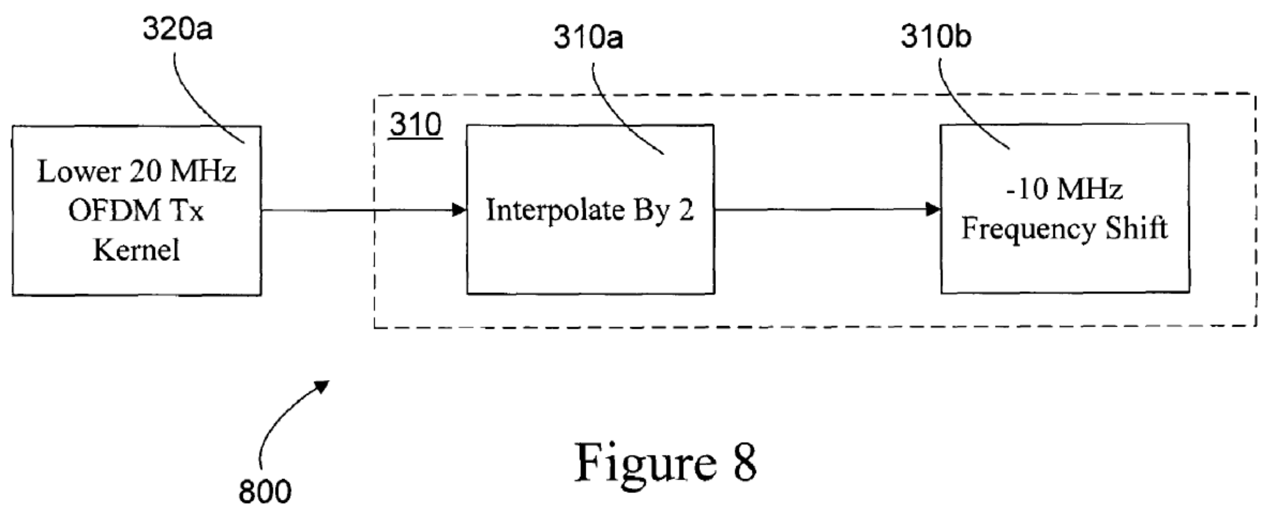
Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 ("802.11") is set out in "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications" and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate "dead spots," and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

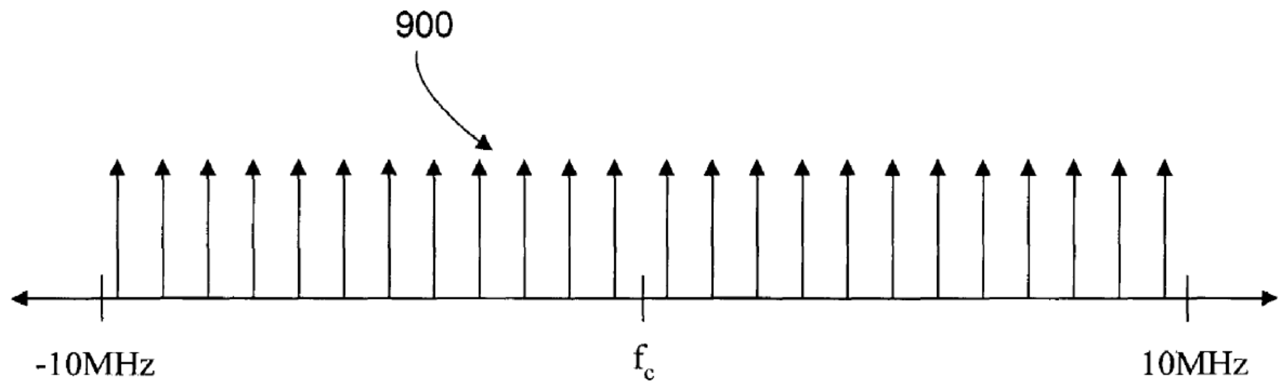
Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See*, *e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

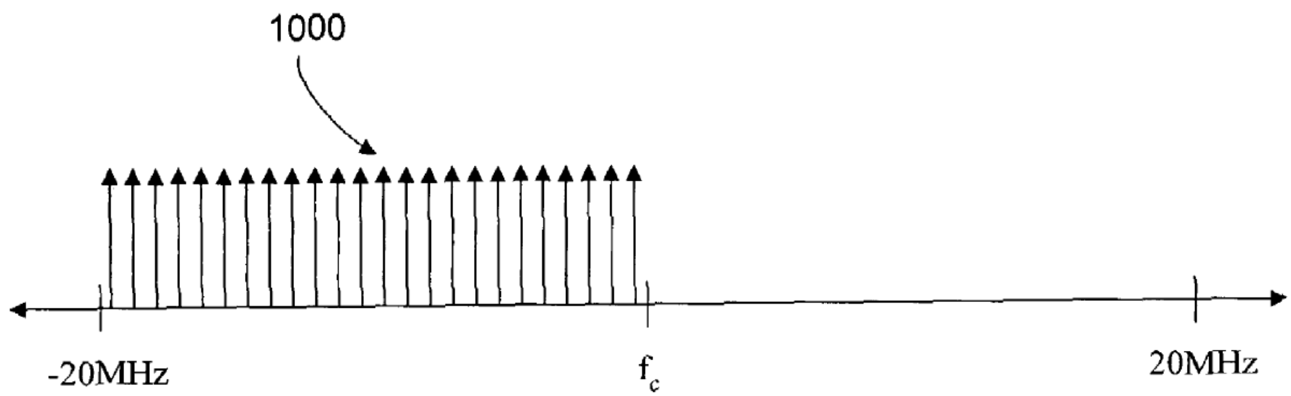
Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

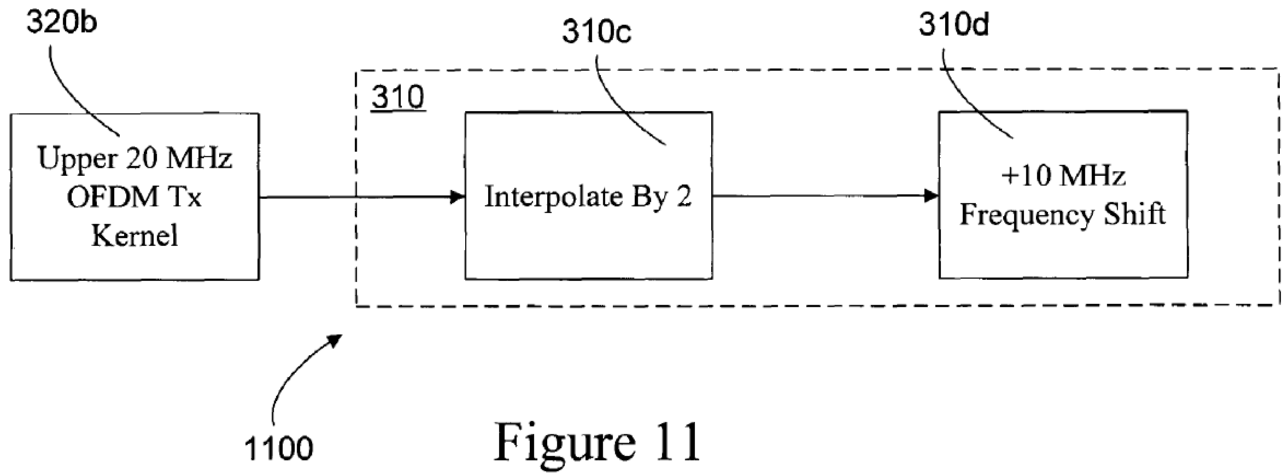
Claim 1 of the ’802 Patent	Prior Art Reference – Shearer
	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

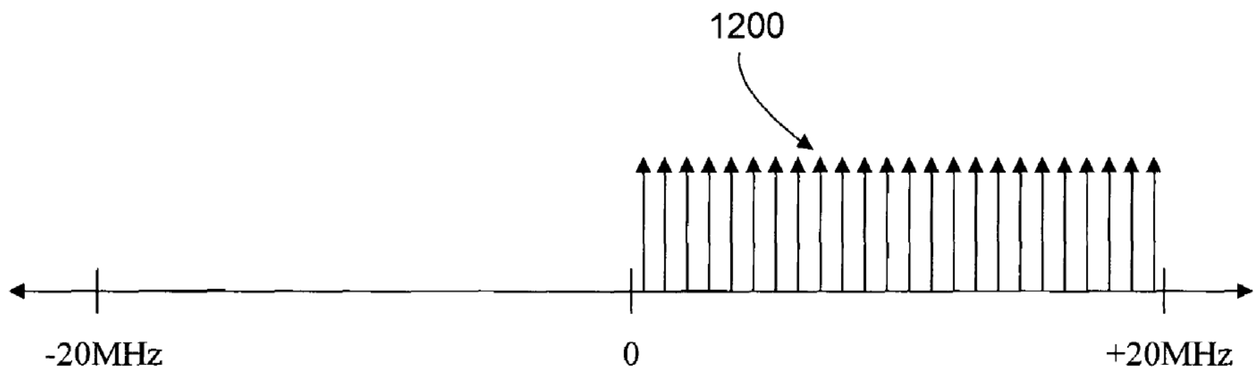
Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

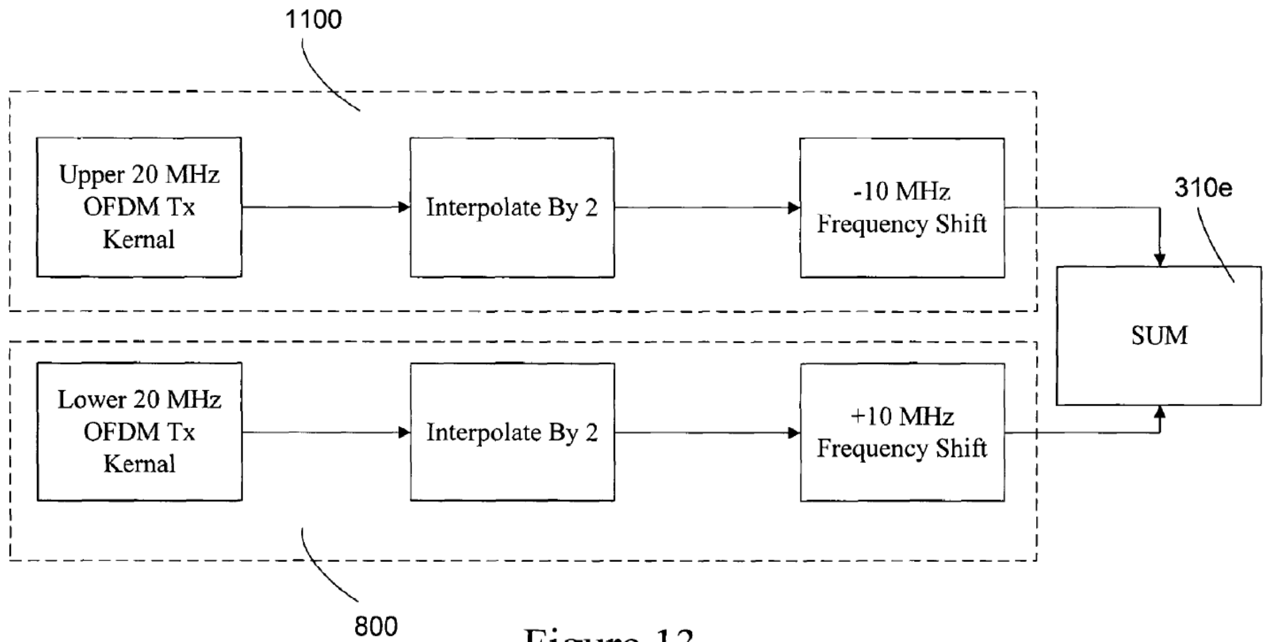
Claim 1 of the ’802 Patent	Prior Art Reference – Shearer
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  *See, e.g.*, Shearer at Figure 8.

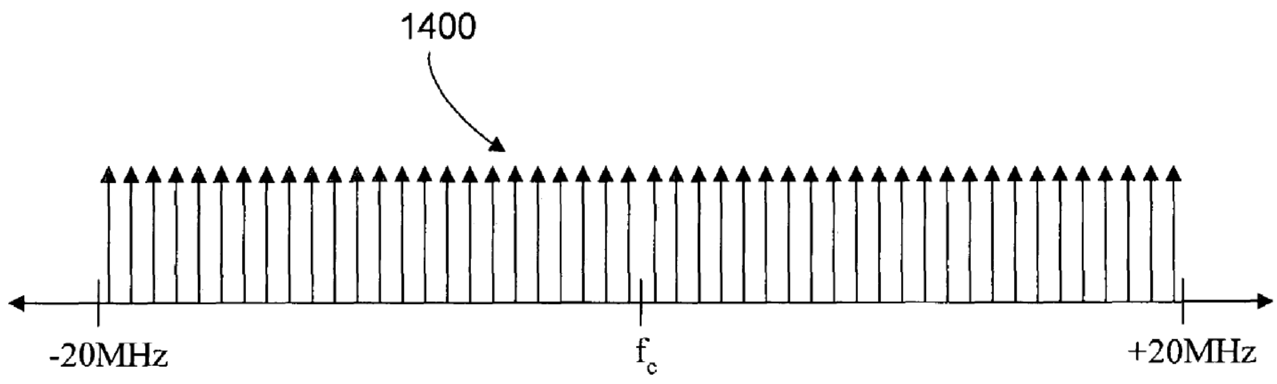
Claim 1 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See*, *e.g.*, Shearer at Figure 9.

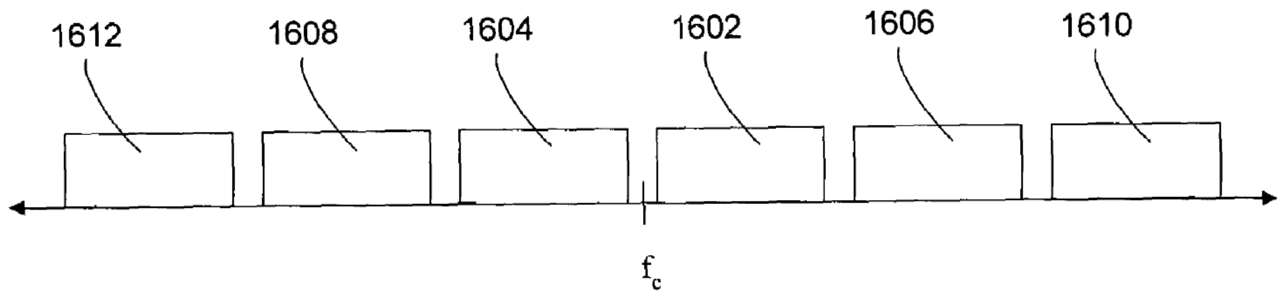
Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

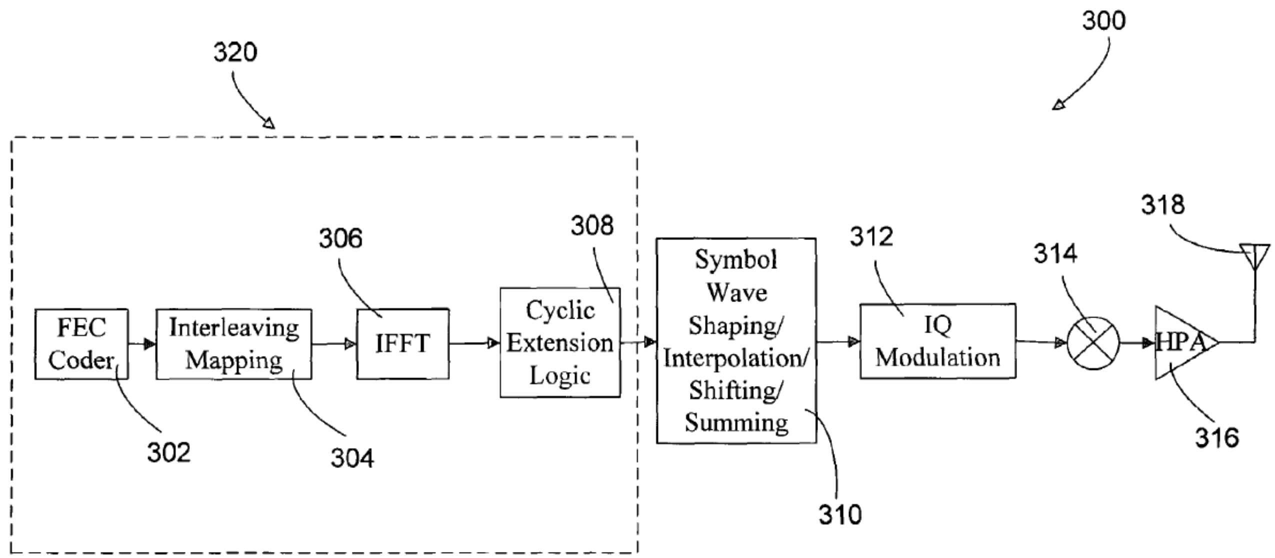
Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 1 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[1.3] simultaneously transmitting second information across a second frequency range using the same wireless transmitter, the second frequency range having a second center frequency greater than the	Shearer discloses “simultaneously transmitting second information across a second frequency range using the same wireless transmitter, the second frequency range having a second center frequency greater than the first center frequency, a second highest frequency, and a second lowest frequency.” See, e.g.:

Claim 1 of the '802 Patent	Prior Art Reference – Shearer
first center frequency, a second highest frequency, and a second lowest frequency.	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

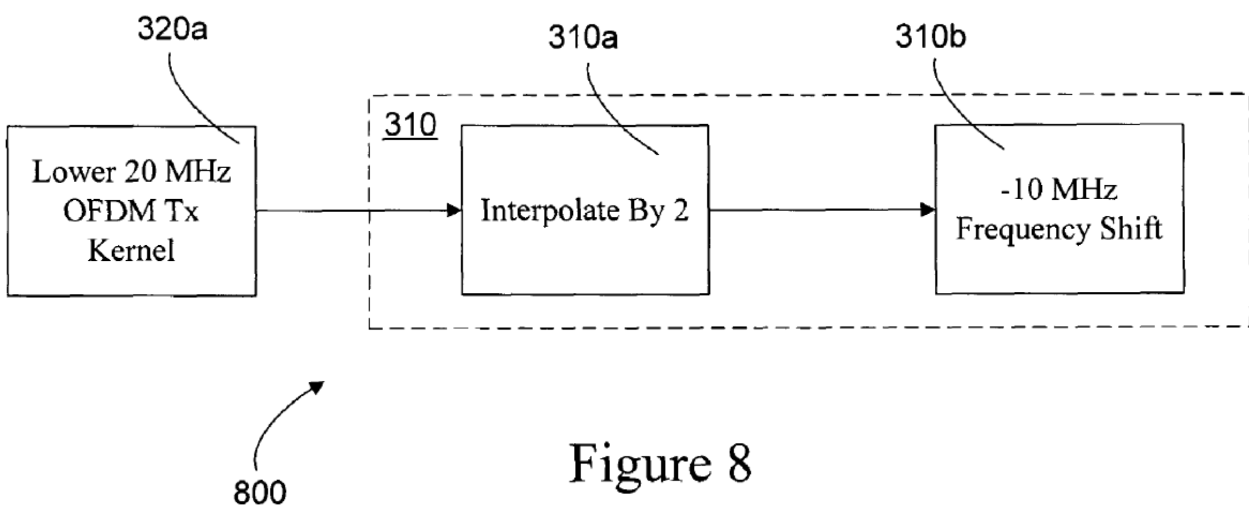
Claim 1 of the ’802 Patent	Prior Art Reference – Shearer
	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

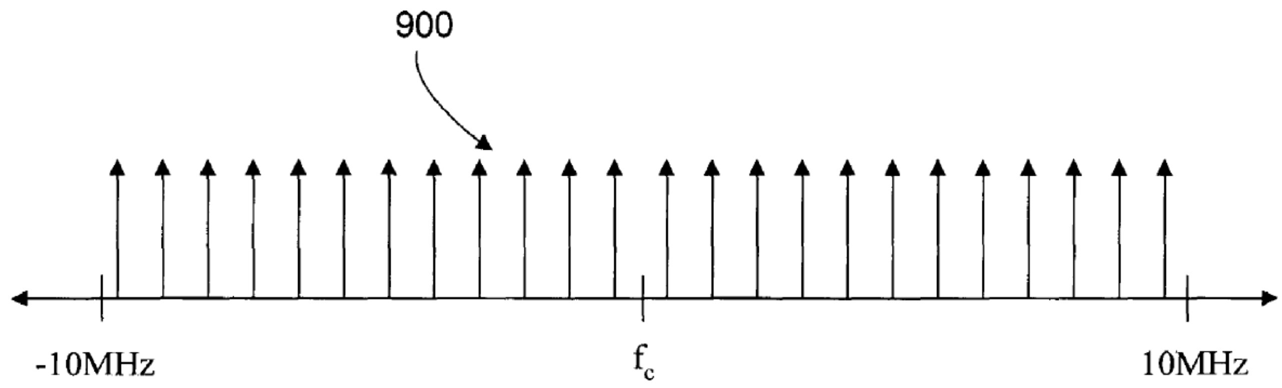
Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

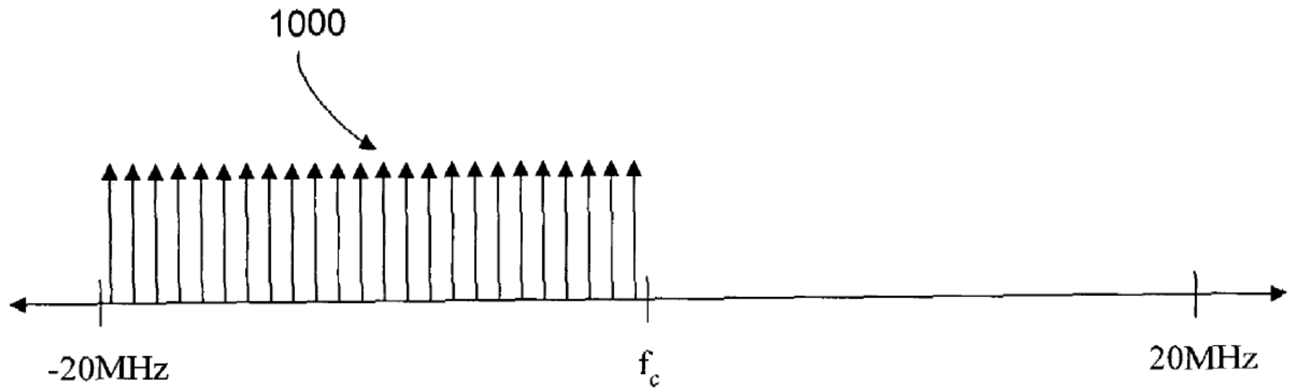
Claim 1 of the ’802 Patent	Prior Art Reference – Shearer
	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

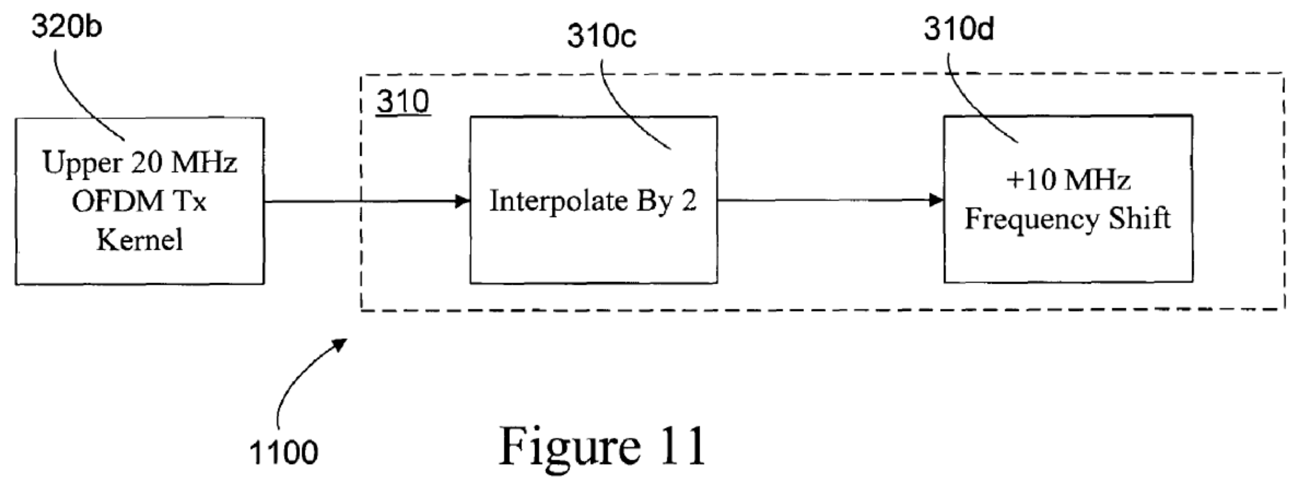
Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

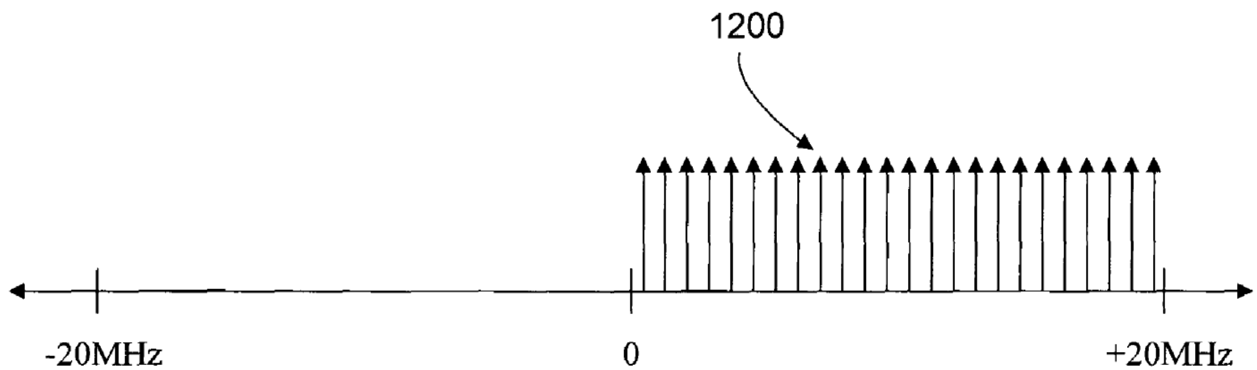
Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

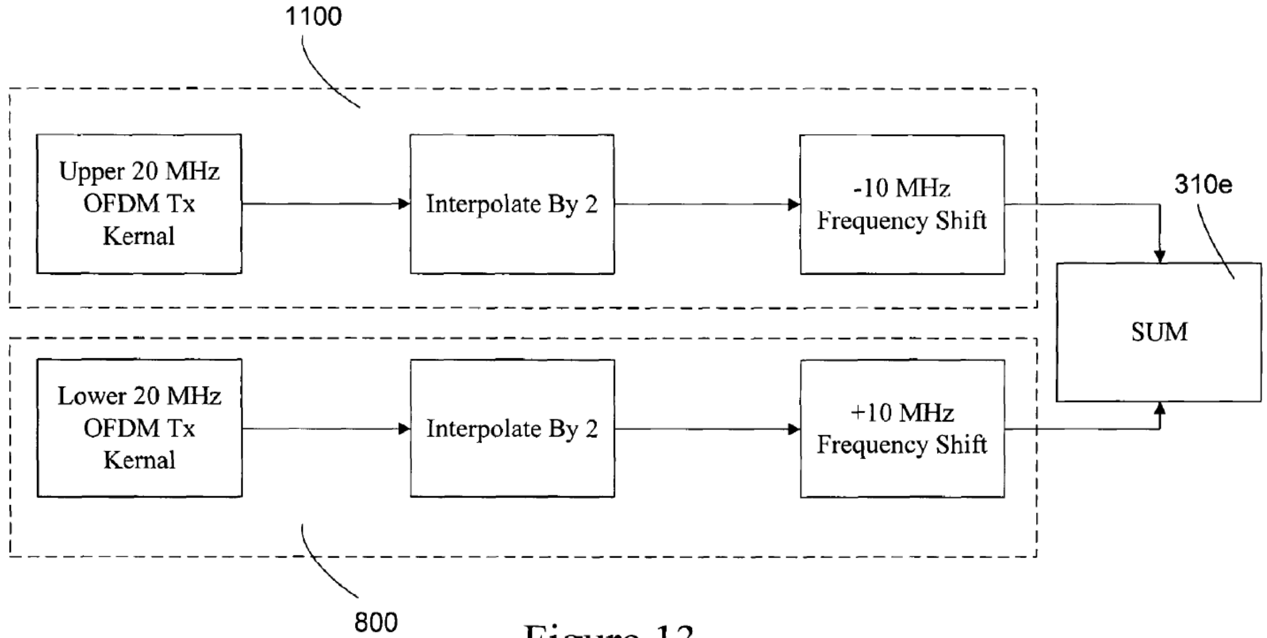
Claim 1 of the ’802 Patent	Prior Art Reference – Shearer
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

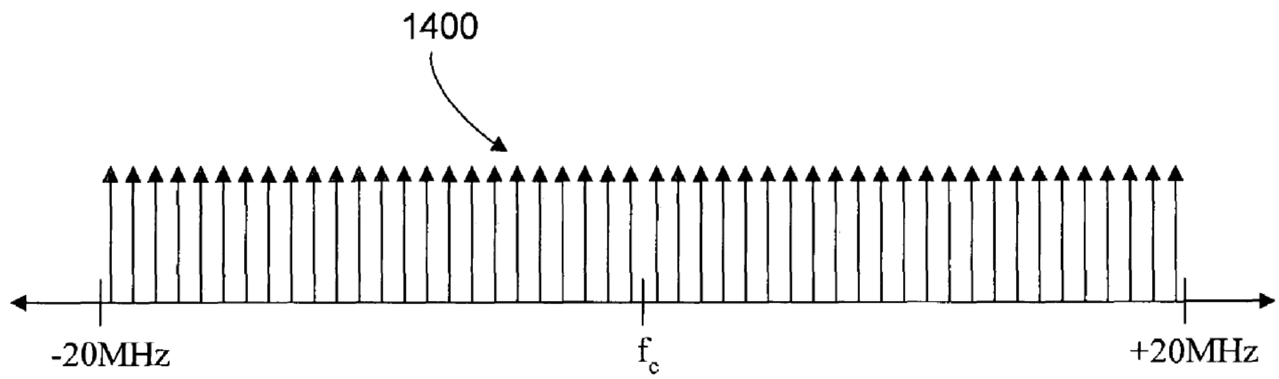
Claim 1 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See*, *e.g.*, Shearer at Figure 9.

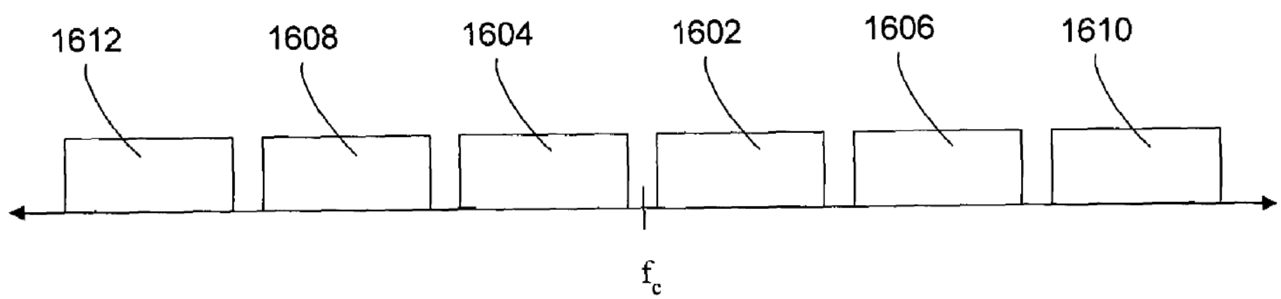
Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

Claim 1 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 1 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 1 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 2 of the ’802 Patent	Prior Art Reference – Shearer
[2.1] The method of claim 1	Shearer discloses all the elements of claim 1 for all the reasons provided above.
[2.2] wherein frequency difference between the first center frequency and the	Shearer discloses “wherein frequency difference between the first center frequency and the second center frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range.” See, e.g.:

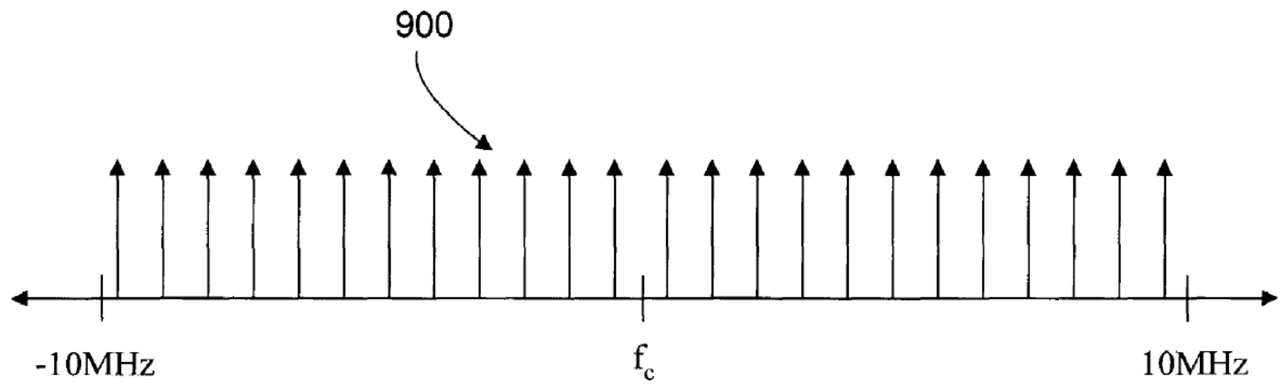
Claim 2 of the ’802 Patent	Prior Art Reference – Shearer
second center frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range.	One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC) code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others.

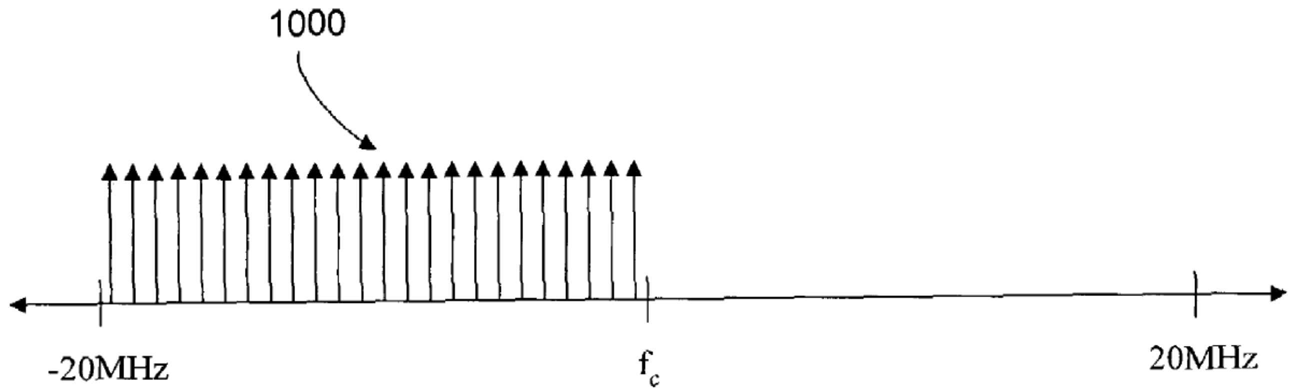
Claim 2 of the '802 Patent	Prior Art Reference – Shearer
	The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers.

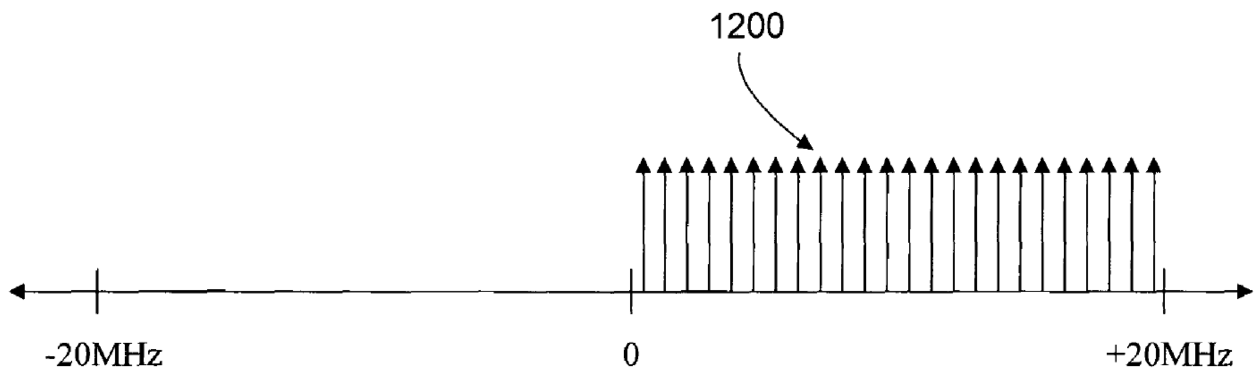
Claim 2 of the '802 Patent	Prior Art Reference – Shearer
	See, e.g., Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10.

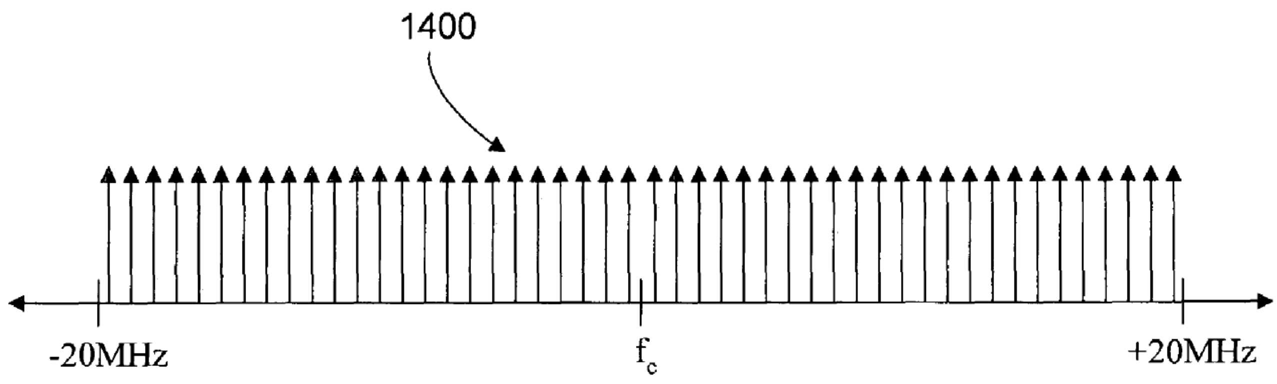
Claim 2 of the '802 Patent	Prior Art Reference – Shearer
	An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even.

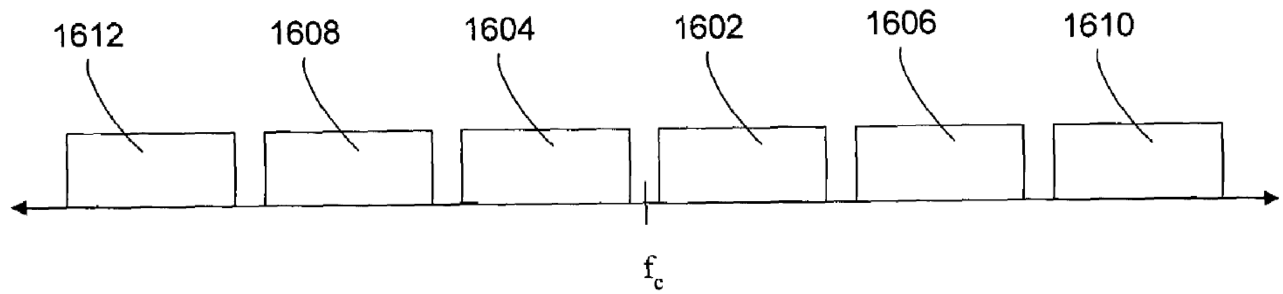
Claim 2 of the ’802 Patent	Prior Art Reference – Shearer
	If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.

Claim 2 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See*, *e.g.*, Shearer at Figure 9.

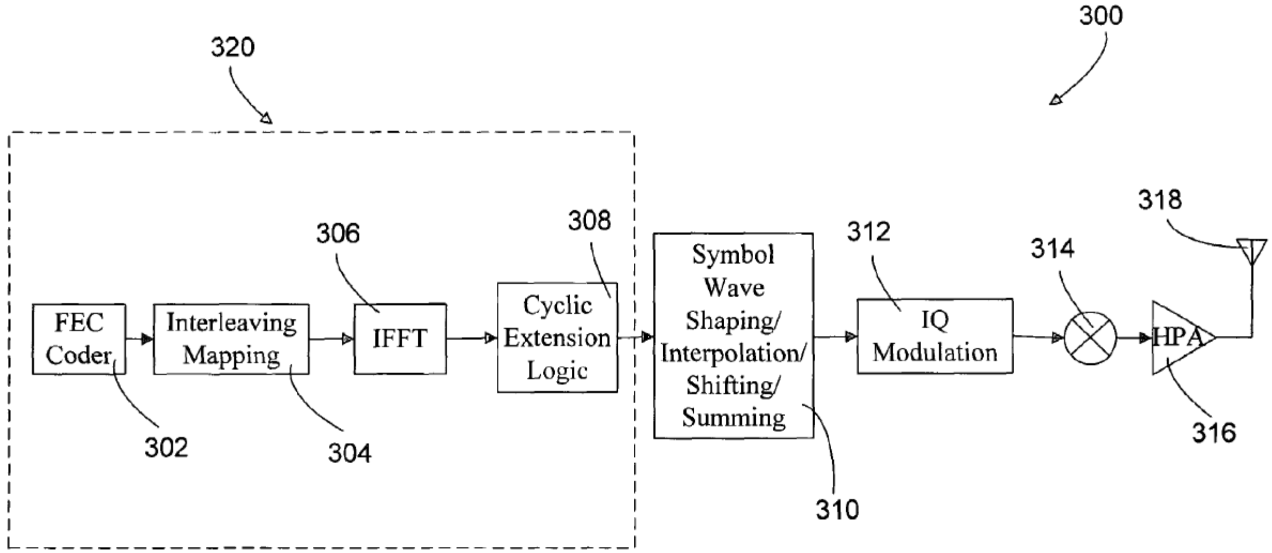
Claim 2 of the '802 Patent	**Prior Art Reference – Shearer**
	 Figure 10 *See, e.g.*, Shearer at Figure 10.

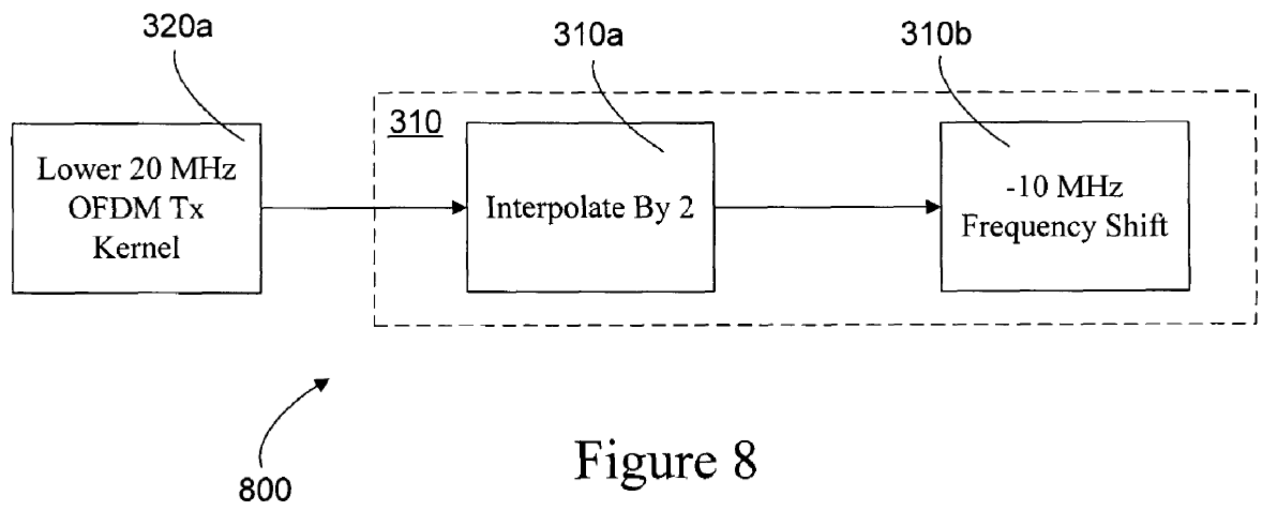
Claim 2 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

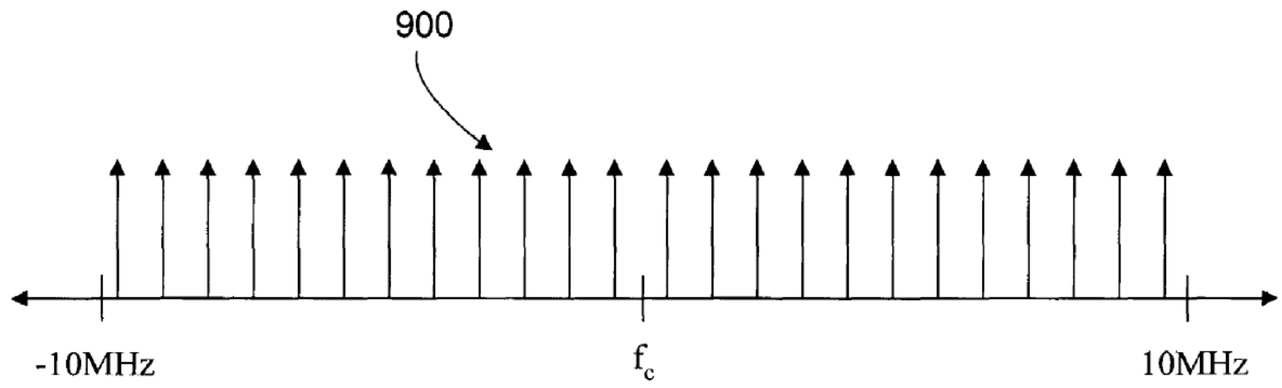
Claim 2 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

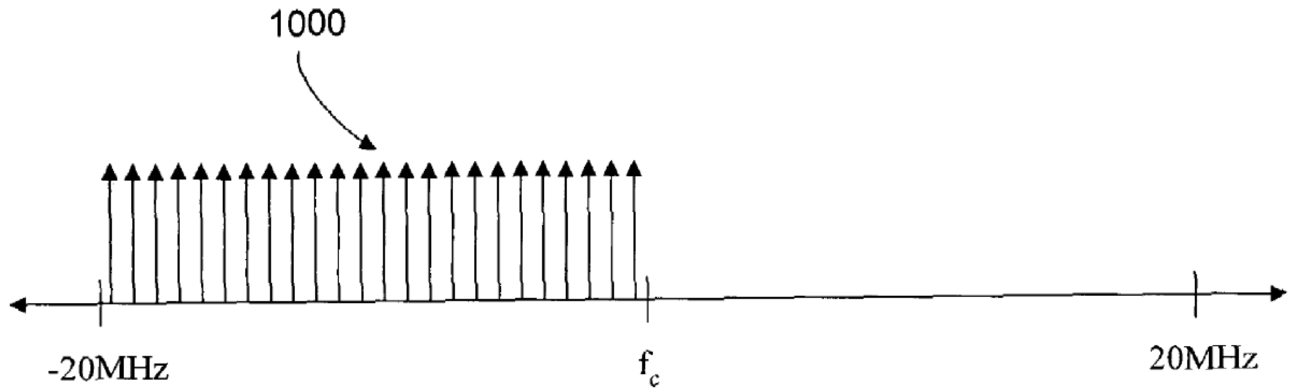
Claim 2 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

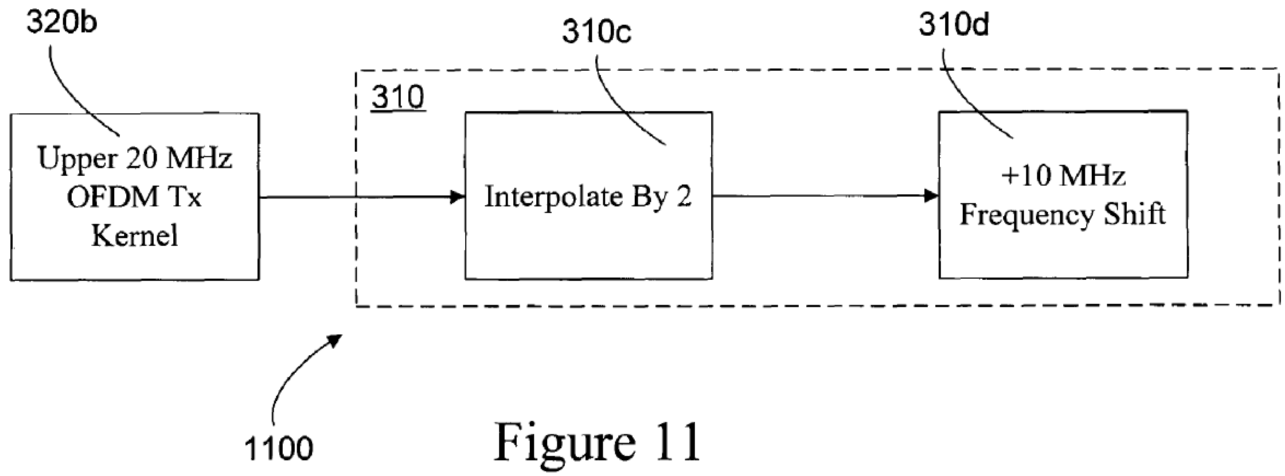
Claim 3 of the ’802 Patent	Prior Art Reference – Shearer
[3.1] The method of claim 1	Shearer discloses all the elements of claim 1 for all the reasons provided above.
[3.2] wherein the first and second information are transmitted using the same	Shearer discloses “wherein the first and second information are transmitted using the same power amplifier in said wireless transmitter.” See, e.g.:

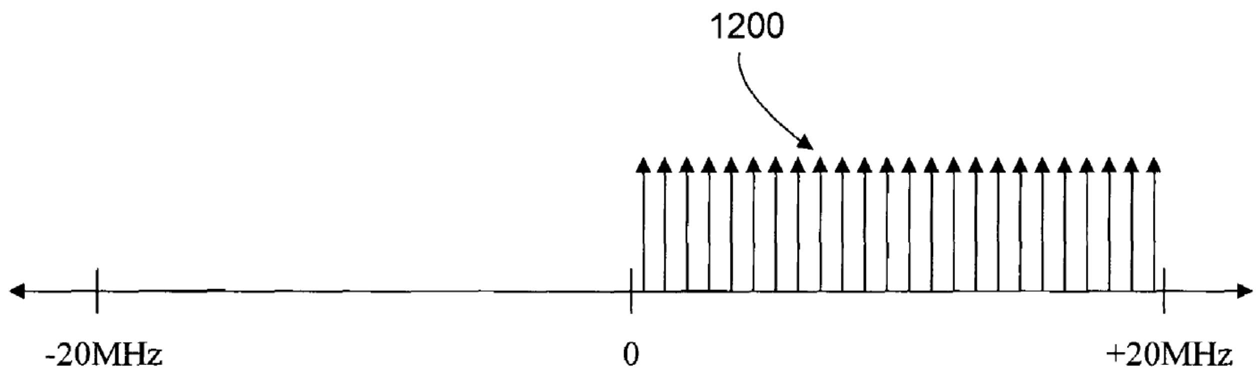
Claim 3 of the '802 Patent	Prior Art Reference – Shearer
power amplifier in said wireless transmitter.	 Figure 3 *See, e.g.*, Shearer at Figure 3.

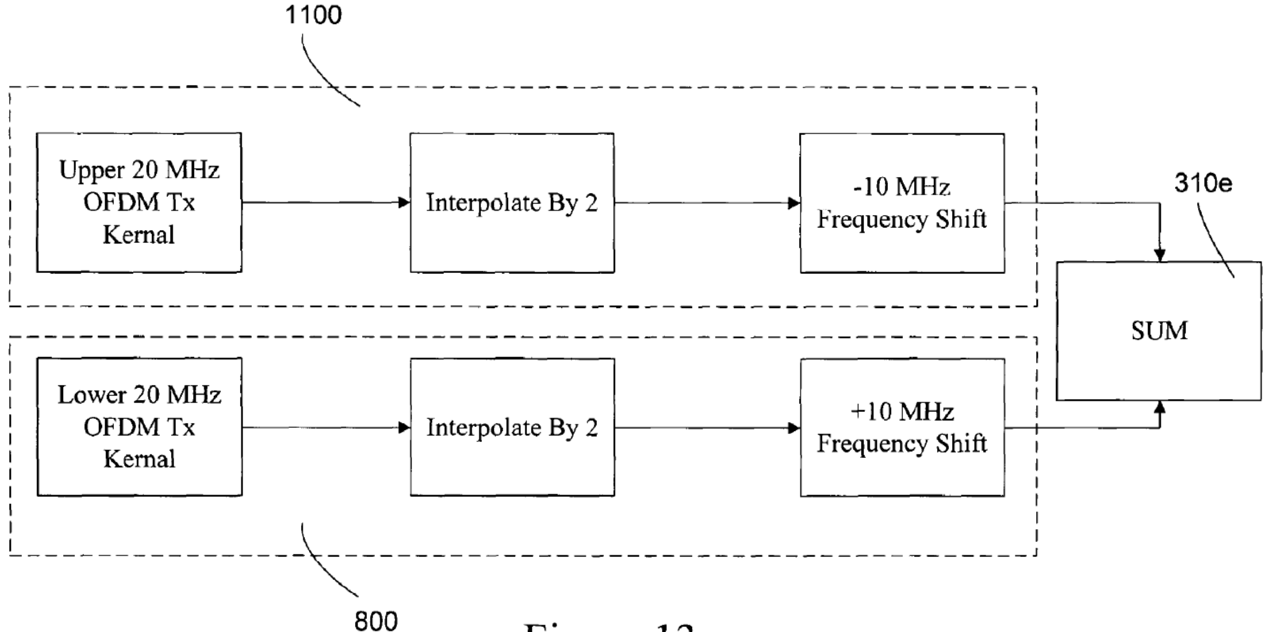
Claim 3 of the '802 Patent	Prior Art Reference – Shearer
	 *See*, *e.g.*, Shearer at Figure 8.

Claim 3 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See, e.g.*, Shearer at Figure 9.

Claim 3 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

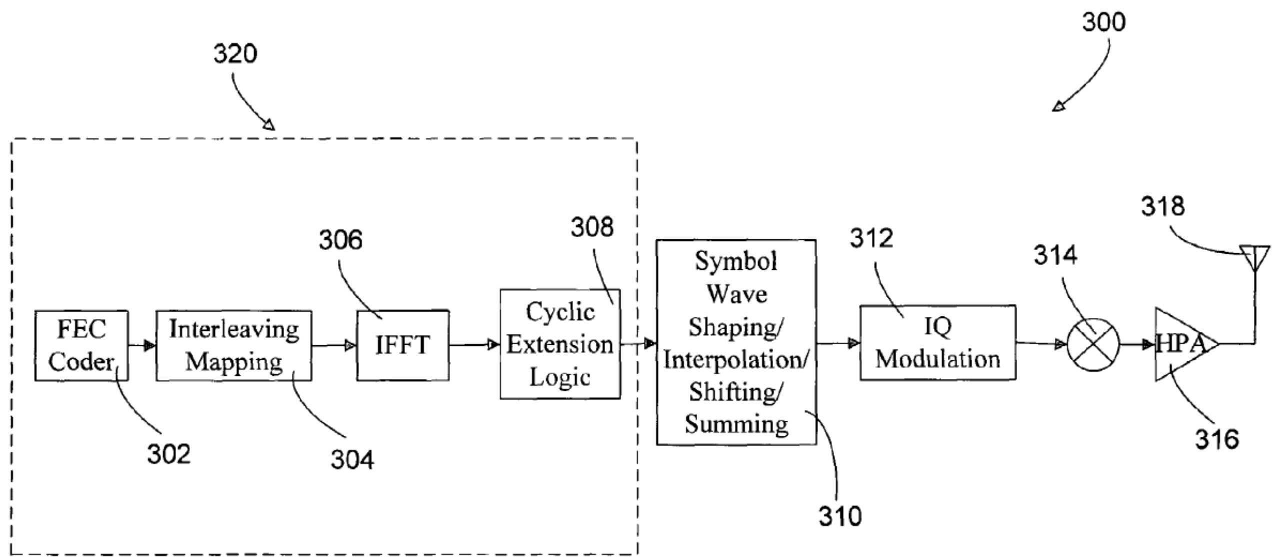
Claim 3 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

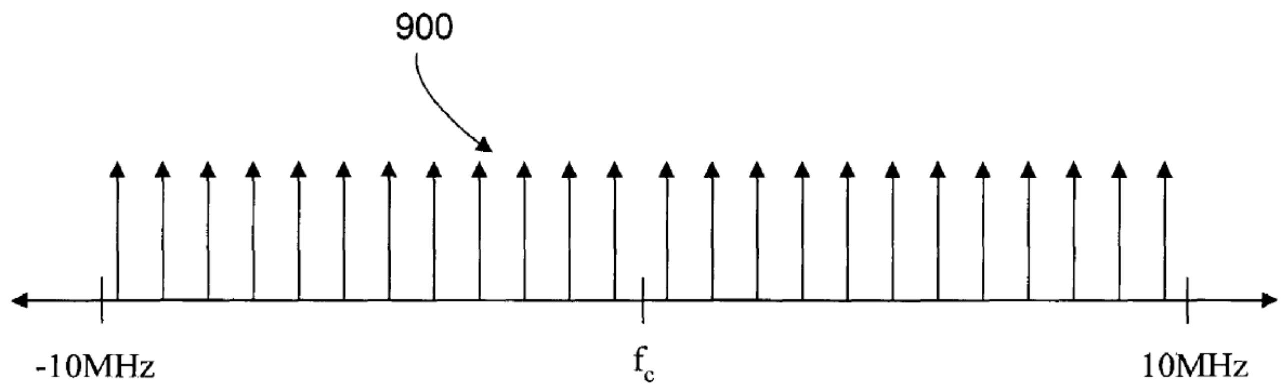
Claim 3 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

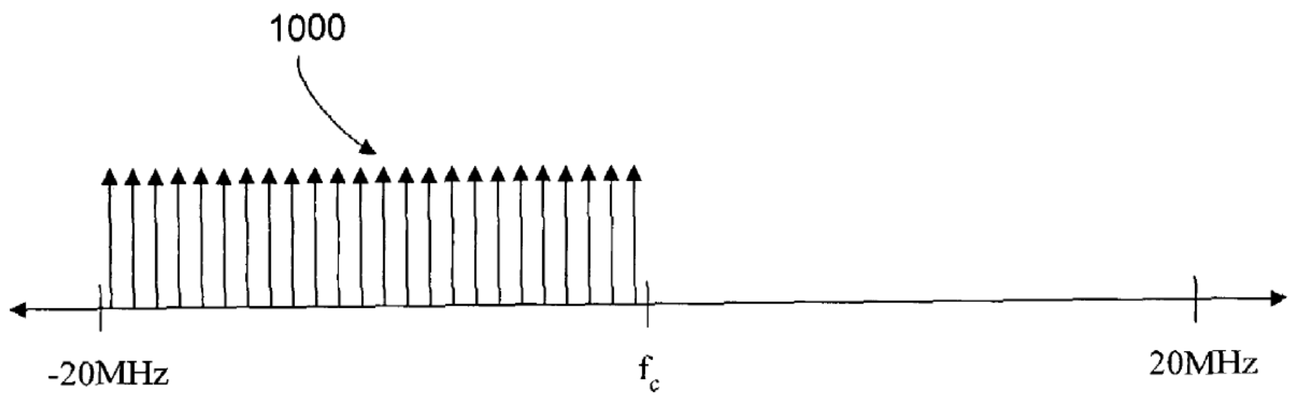
Claim 3 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission.

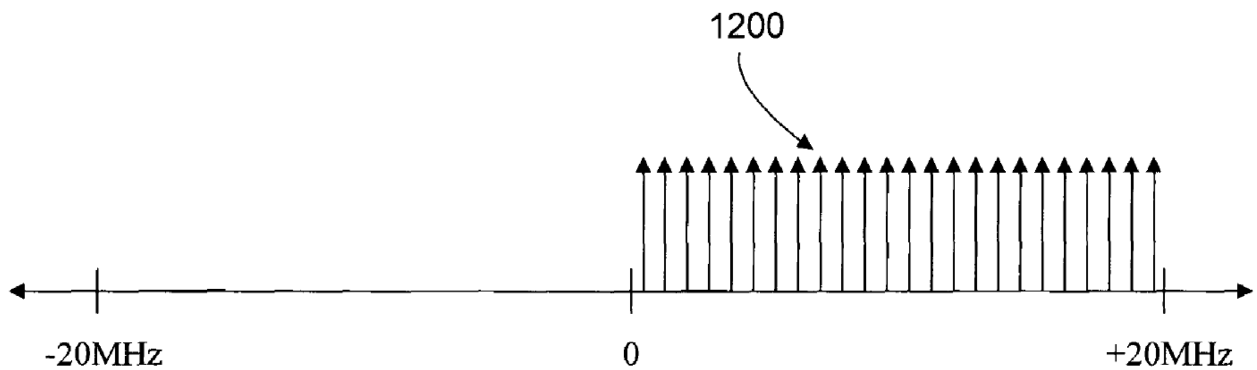
Claim 3 of the '802 Patent	Prior Art Reference – Shearer
	In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See*, *e.g.*, Shearer at 5:30-6:12. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art.

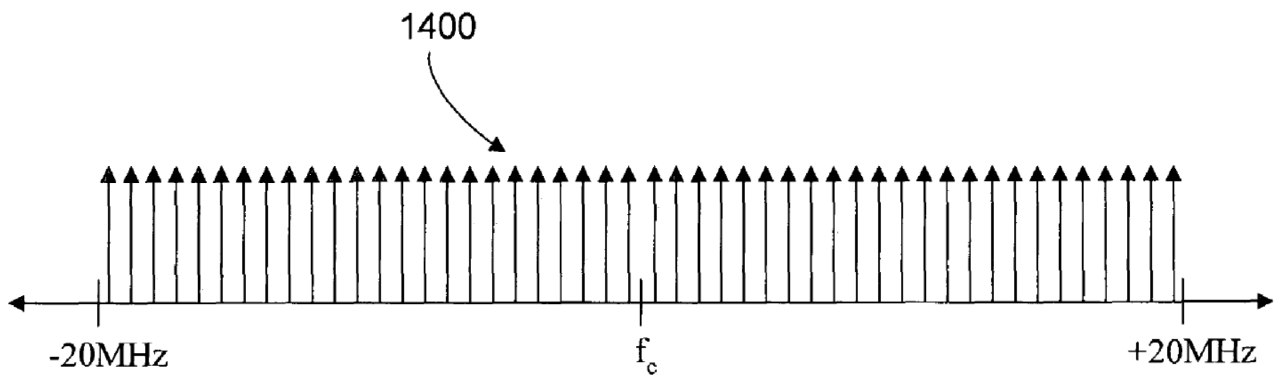
Claim 3 of the ’802 Patent	Prior Art Reference – Shearer
	Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

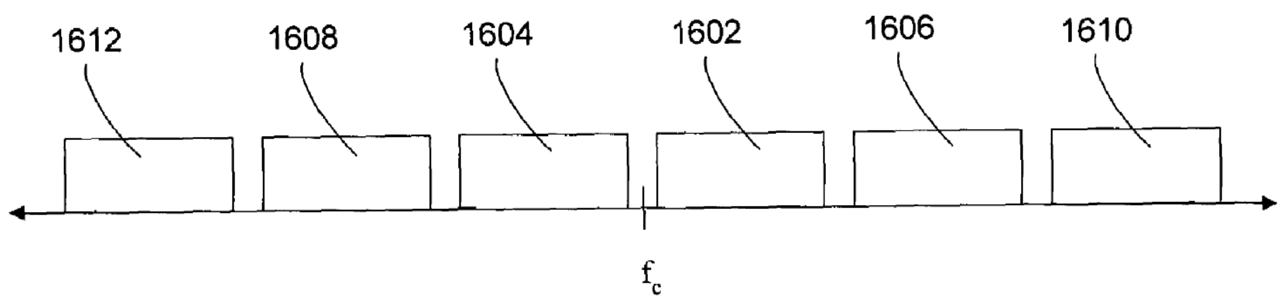
Claim 4 of the ’802 Patent	Prior Art Reference – Shearer
[4.1] The method of claim 3	Shearer discloses all the elements of claim 3 for all the reasons provided above.
[4.2] wherein the bandwidth of said power amplifier is greater than the difference between the first lowest frequency and the second highest frequency.	Shearer discloses “wherein the bandwidth of said power amplifier is greater than the difference between the first lowest frequency and the second highest frequency.” See, e.g.:  Figure 3

Claim 4 of the '802 Patent	Prior Art Reference – Shearer
	See, *e.g.*, Shearer at Figure 3.  Figure 9 *See*, *e.g.*, Shearer at Figure 9.

Claim 4 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

Claim 4 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 4 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 4 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See, e.g.*, Shearer at Figure 16. In an IEEE 802.11 system, as shown in FIG. 7, there is gap 702, 708, 714 between adjacent channels. FIG. 7 provides three different ways to create a 40 MHz wide packet subcarrier layout. Waveform 700 provides a 40 MHz packet's subcarrier structure matching the subcarrier structure of two 20 MHz 802.11a/g OFDM packets, whose center frequencies are spaced by 10 MHz. Waveform 706 adds extra subcarriers to the gap in the middle, on the inner spectral edges of the two 20 MHz sub-packets. Waveform 712 adds extra subcarriers to the outer and inner edges of the sub-packets. Each of these 40 MHz constructions 700, 706, 712, is advantageous to a receiver, since the similarity in subcarrier layout facilitates processing in the receiver, especially, in the instance when a 20 MHz packet is received in either the upper or lower 20 MHz channel of the 40 MHz wide bandwidth, for example. *See, e.g.*, Shearer at 6:29-44. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even.

Claim 4 of the ’802 Patent	Prior Art Reference – Shearer
	If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See*, *e.g.*, Shearer at 9:25-54. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 6 of the ’802 Patent	Prior Art Reference – Shearer
[6.1] The method of claim 1	Shearer discloses all the elements of claim 1 for all the reasons provided above.

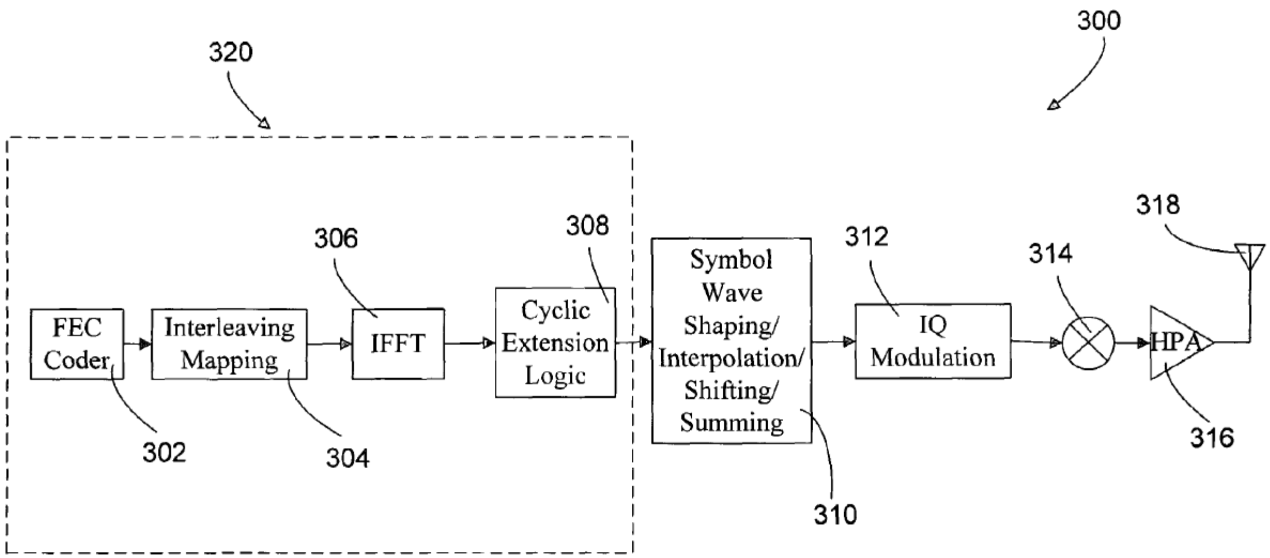
Claim 6 of the '802 Patent	**Prior Art Reference – Shearer**
[6.2] wherein the first information corresponds to a first wireless protocol and the second information corresponds to a second wireless protocol.	Shearer discloses "wherein the first information corresponds to a first wireless protocol and the second information corresponds to a second wireless protocol." See, e.g.: A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 ("802.11") is set out in "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications" and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate "dead spots," and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate

Claim 6 of the '802 Patent	Prior Art Reference – Shearer
	with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See*, *e.g.*, Shearer at 1:31-2:5. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift.

Claim 6 of the '802 Patent	Prior Art Reference – Shearer
	FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See*, *e.g.*, Shearer at 8:17-9:24.

Claim 6 of the '802 Patent	Prior Art Reference – Shearer
	Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 7 of the '802 Patent	Prior Art Reference – Shearer
[7.1] The method of claim 1	Shearer discloses all the elements of claim 1 for all the reasons provided above.
[7.2] wherein the first information and the second information are the same data transmitted across two different frequencies.	Shearer discloses "wherein the first information and the second information are the same data transmitted across two different frequencies." See, e.g.:

Claim 7 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

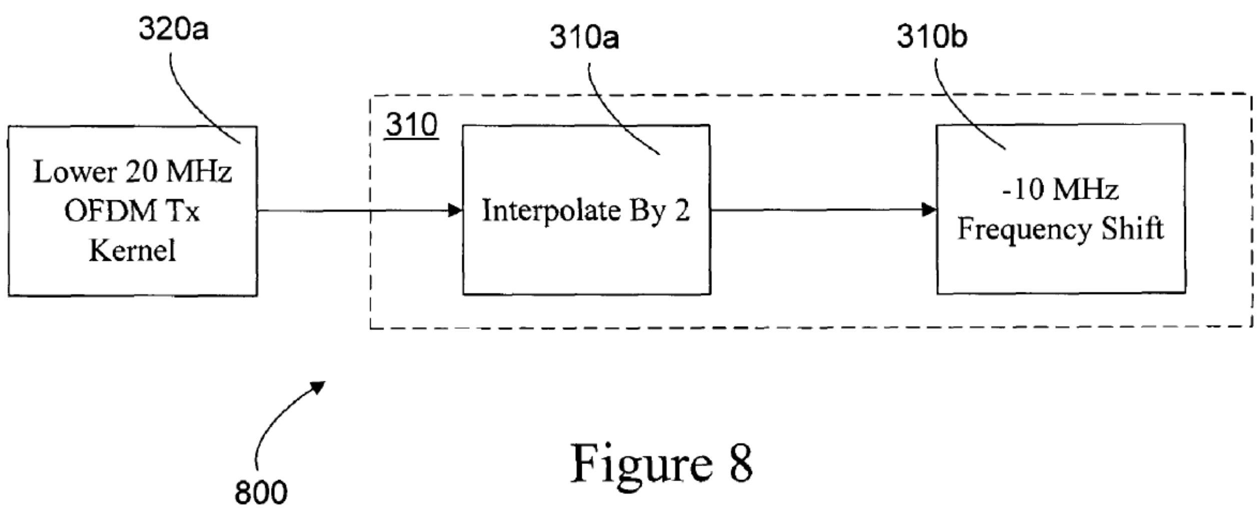
Claim 7 of the ’802 Patent	Prior Art Reference – Shearer
	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

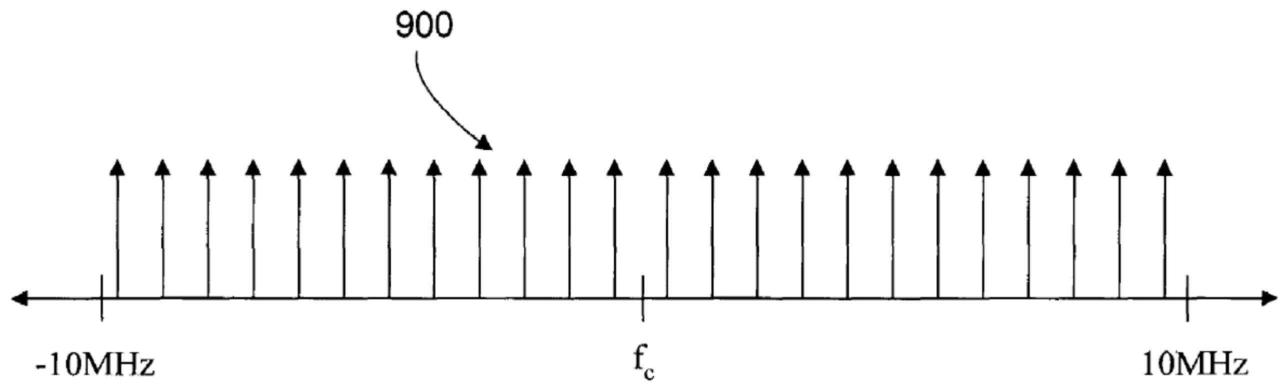
Claim 7 of the ’802 Patent	Prior Art Reference – Shearer
	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See*, *e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

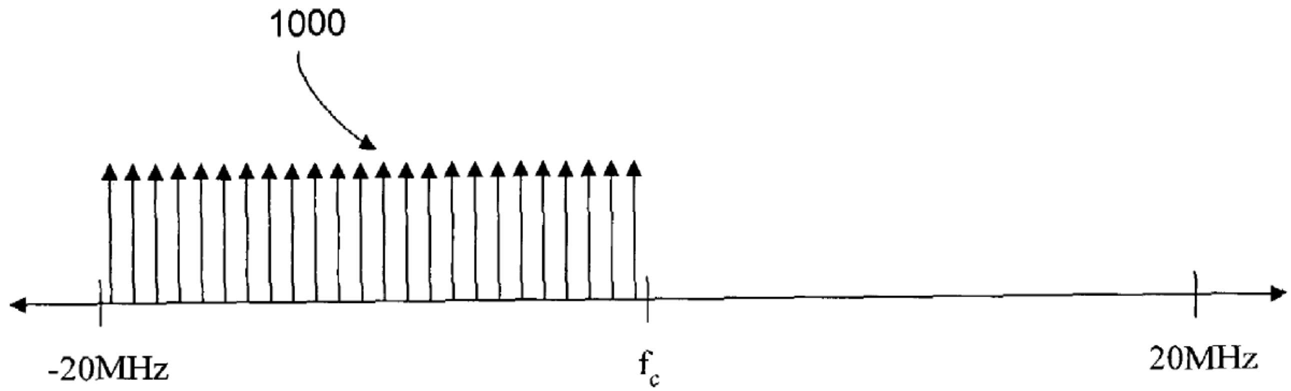
Claim 7 of the ’802 Patent	Prior Art Reference – Shearer
	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

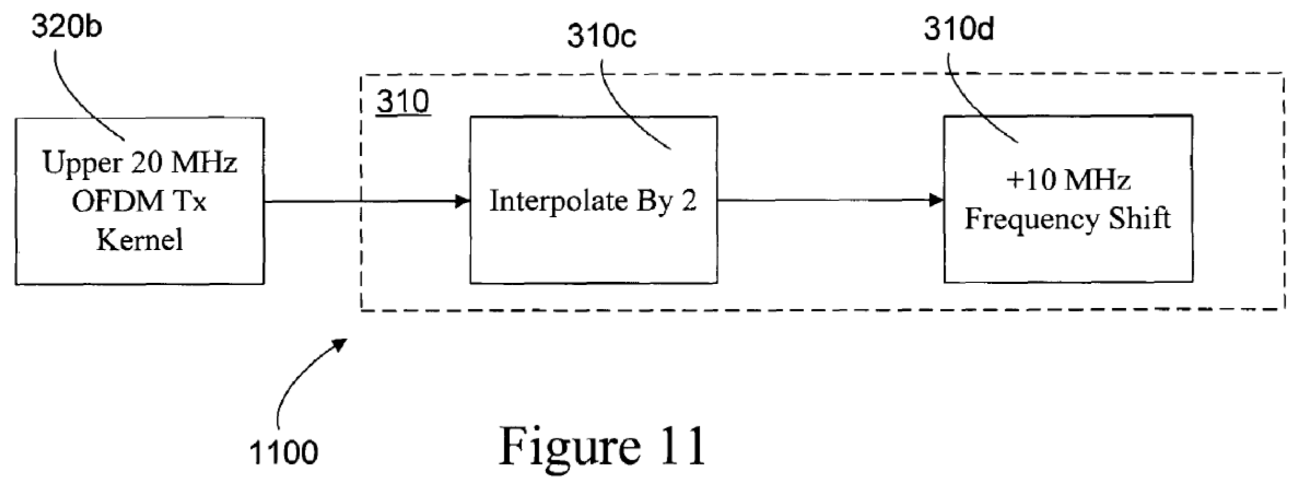
Claim 7 of the '802 Patent	Prior Art Reference – Shearer
	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

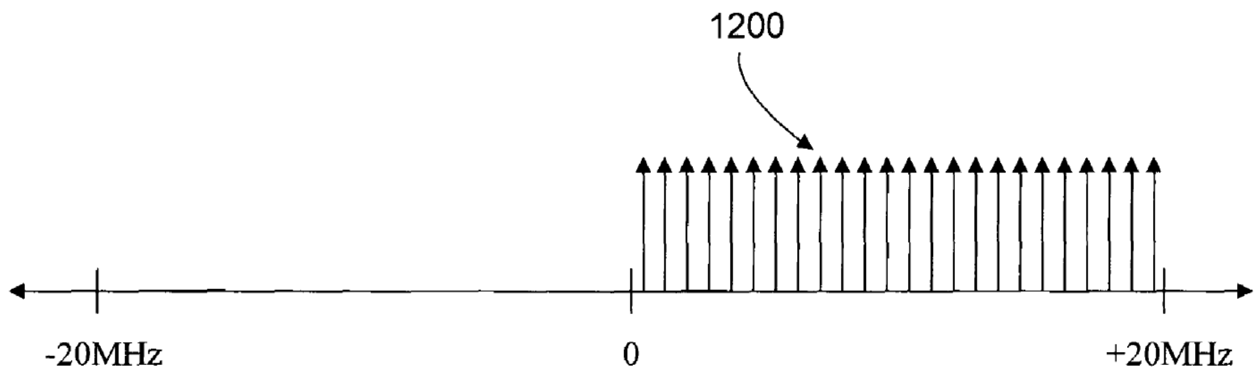
Claim 7 of the '802 Patent	Prior Art Reference – Shearer
	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

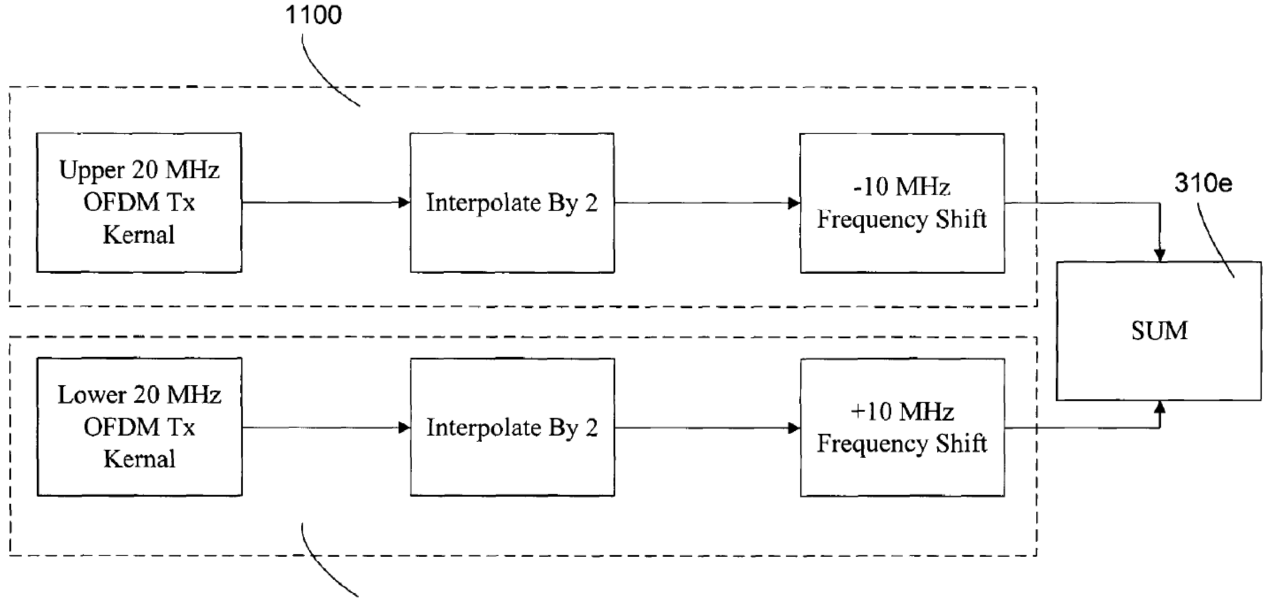
Claim 7 of the '802 Patent	Prior Art Reference – Shearer
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

Claim 7 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See*, *e.g.*, Shearer at Figure 9.

Claim 7 of the ’802 Patent	**Prior Art Reference – Shearer**
	 Figure 10 *See, e.g.*, Shearer at Figure 10.

Claim 7 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

Claim 7 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

<table>
<tr><th>Claim 7 of the ’802 Patent</th><th>Prior Art Reference – Shearer</th></tr>
<tr><td></td><td>
Figure 13

See, e.g., Shearer at Figure 13.</td></tr>
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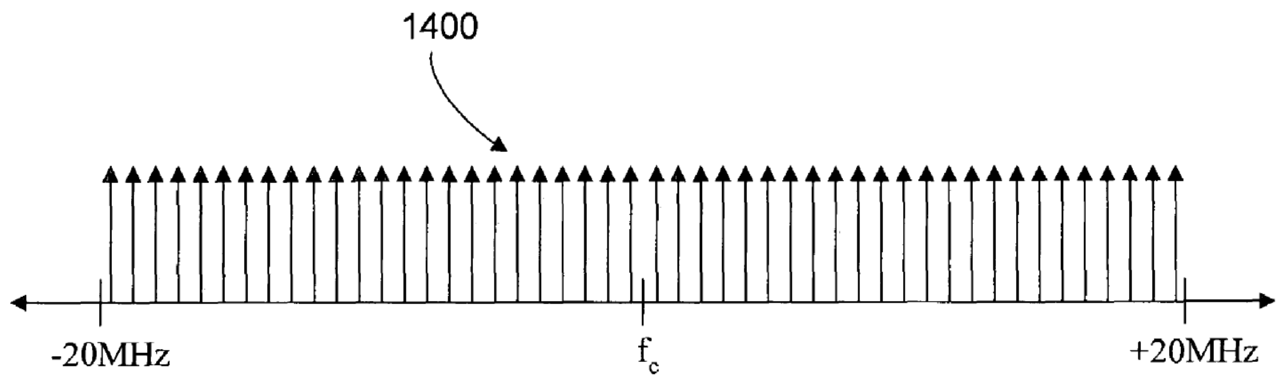
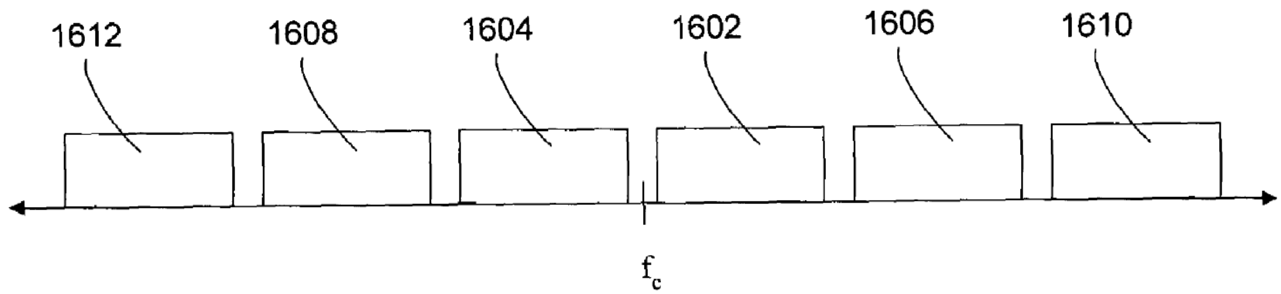
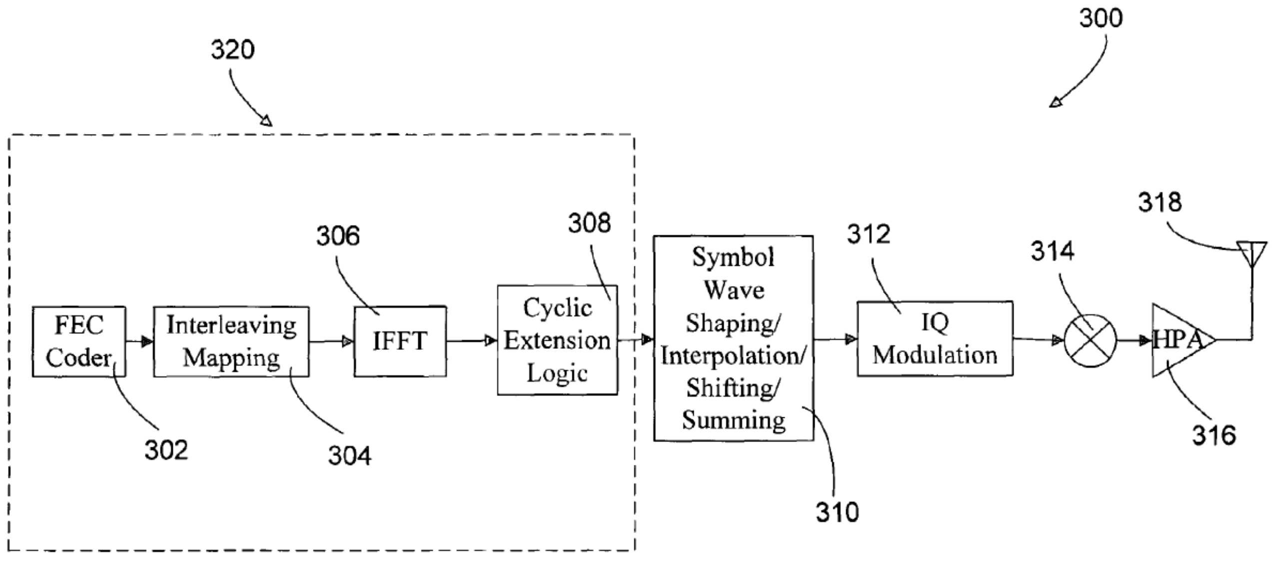
Claim 7 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 7 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See*, *e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 8 of the ’802 Patent	Prior Art Reference – Shearer
[8.1] The method of claim 1	Shearer discloses all the elements of claim 1 for all the reasons provided above.
[8.2] wherein the first information and the second	Shearer discloses “wherein the first information and the second information are from the same data stream.” See, e.g.:

Claim 8 of the ’802 Patent	Prior Art Reference – Shearer
information are from the same data stream.	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host

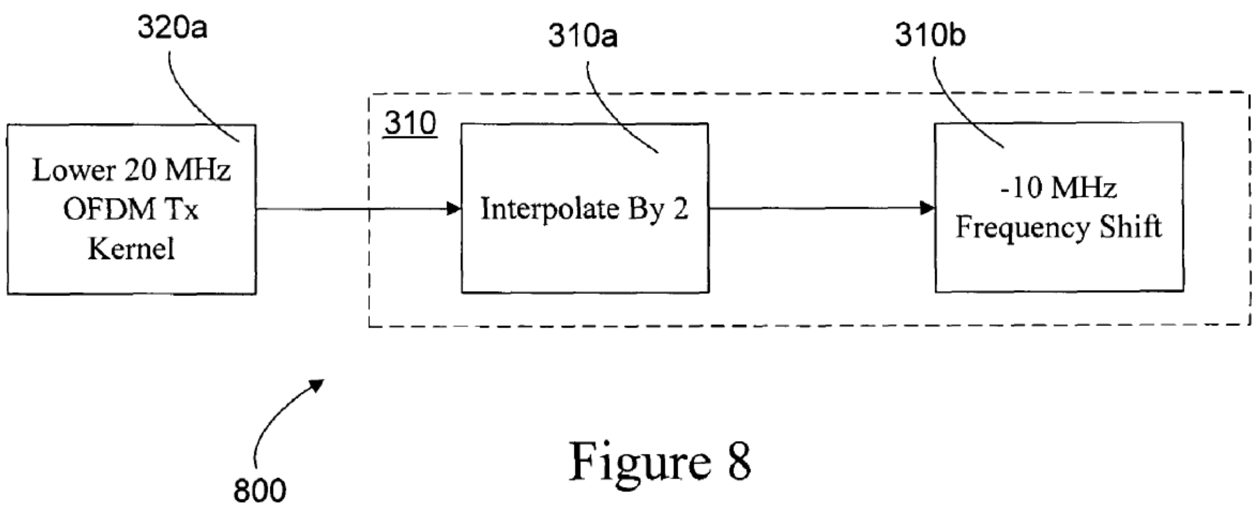
Claim 8 of the ’802 Patent	Prior Art Reference – Shearer
	computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308.

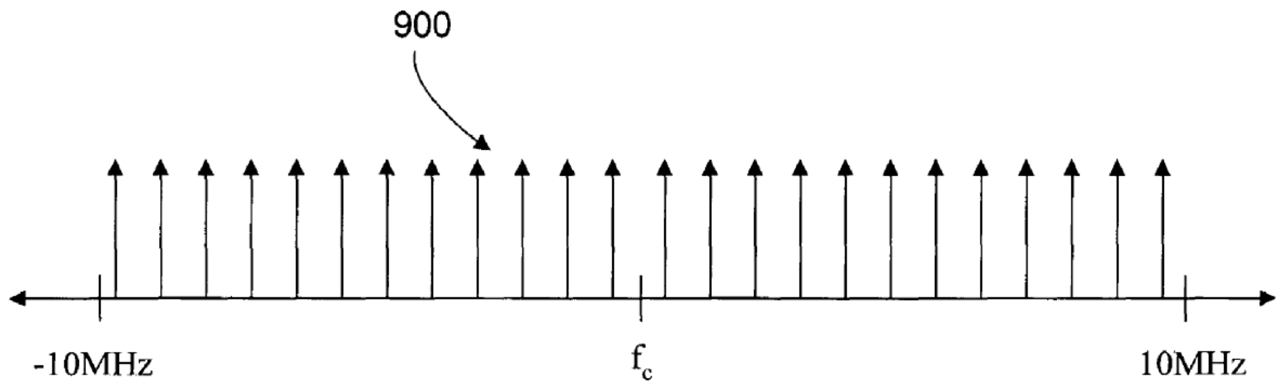
Claim 8 of the ’802 Patent	Prior Art Reference – Shearer
	During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC) code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz

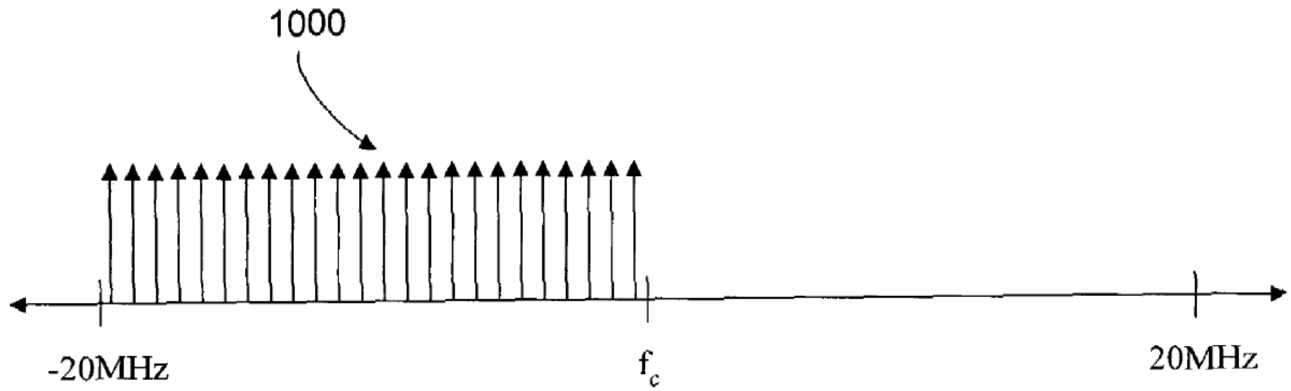
Claim 8 of the '802 Patent	Prior Art Reference – Shearer
	channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A

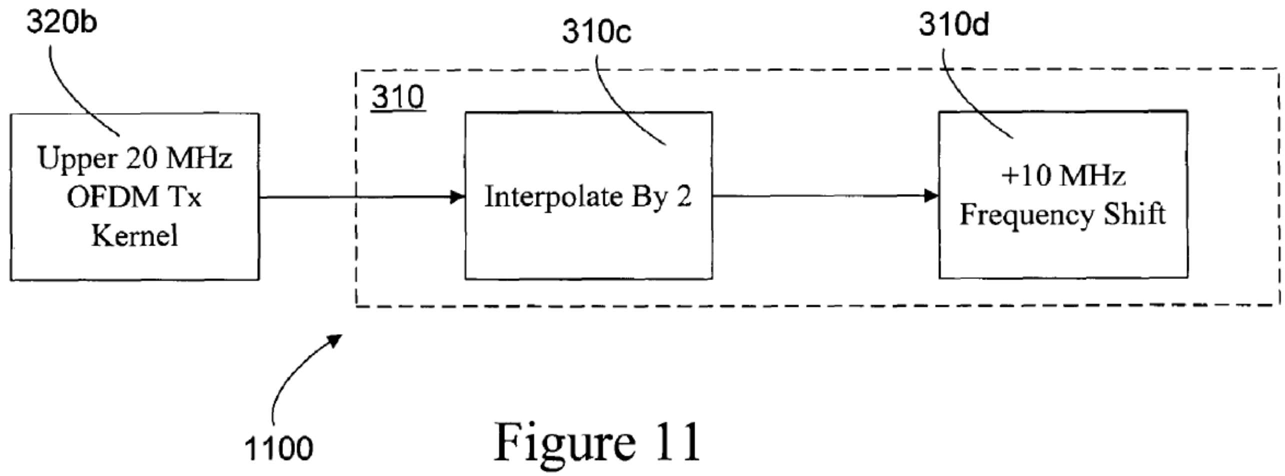
Claim 8 of the '802 Patent	Prior Art Reference – Shearer
	lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are

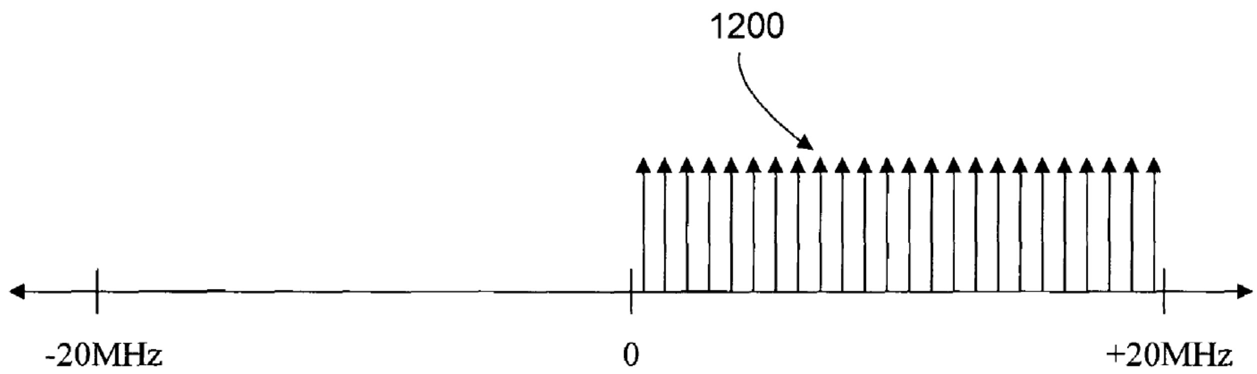
Claim 8 of the ’802 Patent	Prior Art Reference – Shearer
	received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for

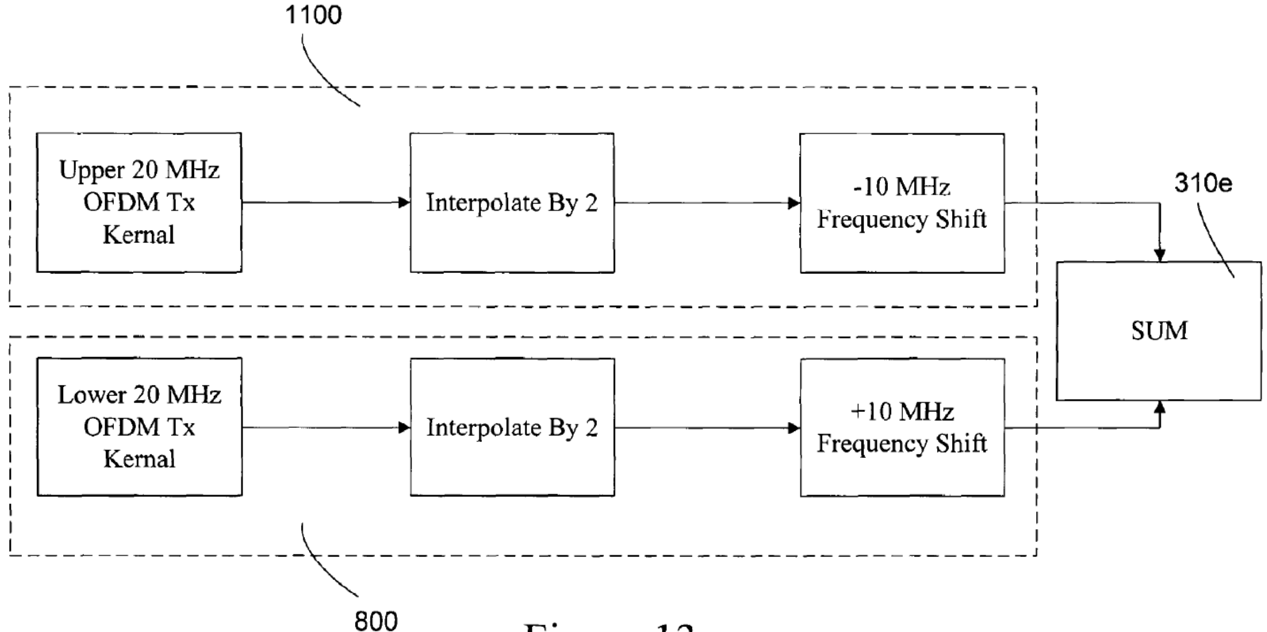
Claim 8 of the ’802 Patent	Prior Art Reference – Shearer
	transmission. This process is applicable for any even number of input signals. Each simultaneous input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See*, *e.g.*, Shearer at 9:25-54.  Figure 8 *See*, *e.g.*, Shearer at Figure 8.

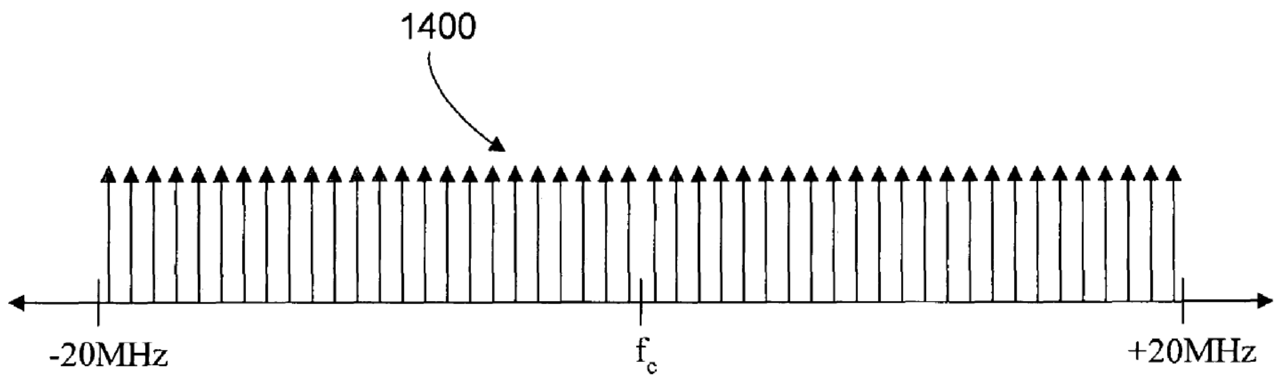
Claim 8 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See, e.g.*, Shearer at Figure 9.

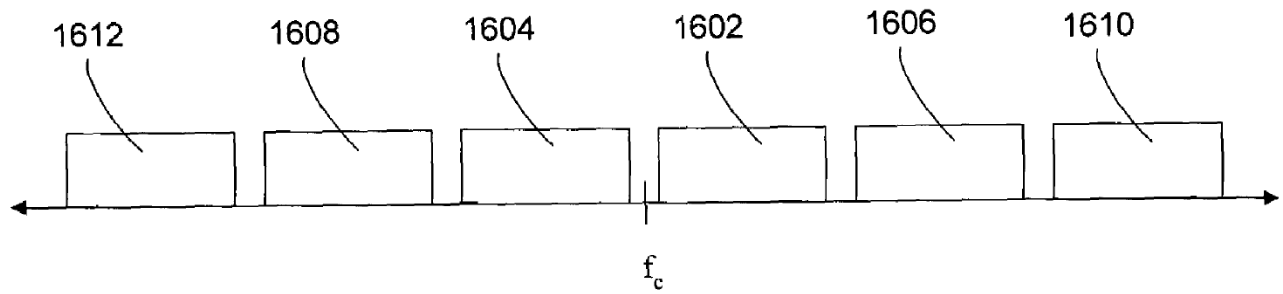
Claim 8 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See, e.g.*, Shearer at Figure 10.

Claim 8 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

Claim 8 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 8 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 8 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 8 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

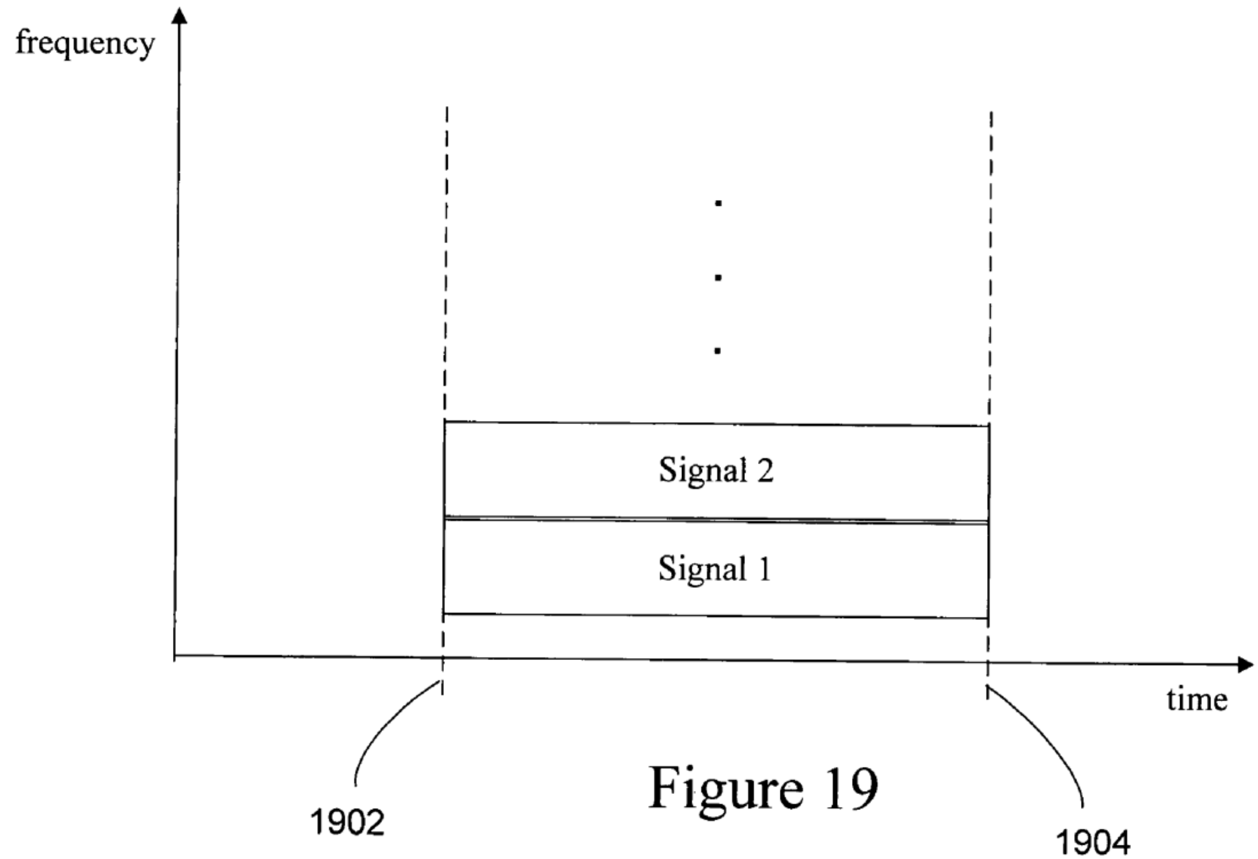
Claim 9 of the '802 Patent	Prior Art Reference – Shearer
[9.1] The method of claim 1	Shearer discloses all the elements of claim 1 for all the reasons provided above.
[9.2] wherein first information and second information comprise a plurality of OFDM	Shearer discloses "wherein first information and second information comprise a plurality of OFDM symbols, wherein a first symbol is transmitted during a first time slot across the first frequency range and a second symbol is transmitted during the first time slot across the second frequency range, and

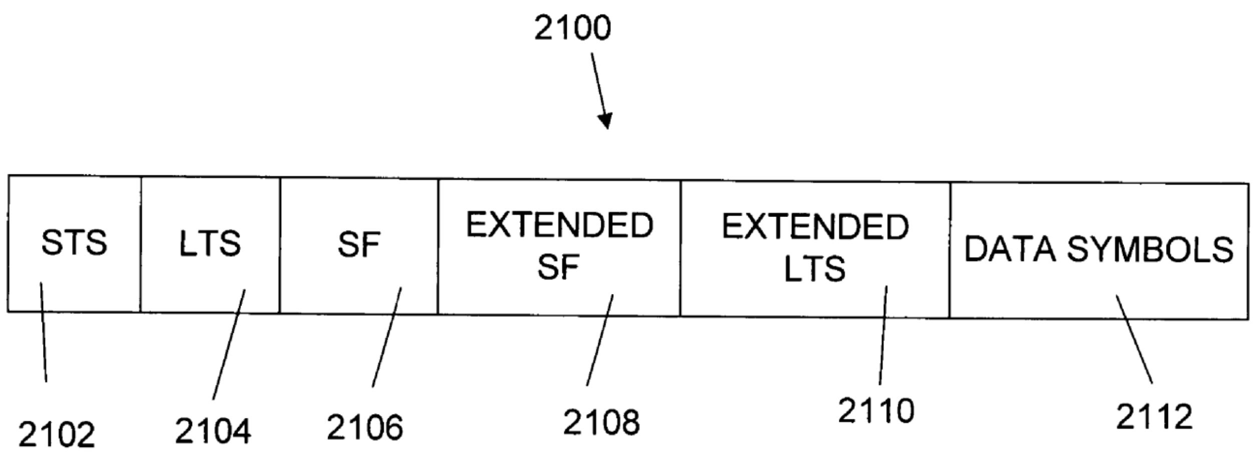
Claim 9 of the '802 Patent	Prior Art Reference – Shearer
symbols, wherein a first symbol is transmitted during a first time slot across the first frequency range and a second symbol is transmitted during the first time slot across the second frequency range, and wherein a third symbol is transmitted during a second time slot across the first frequency range and a fourth symbol is transmitted during the second time slot across a second frequency range.	wherein a third symbol is transmitted during a second time slot across the first frequency range and a fourth symbol is transmitted during the second time slot across a second frequency range." See, e.g.: The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The

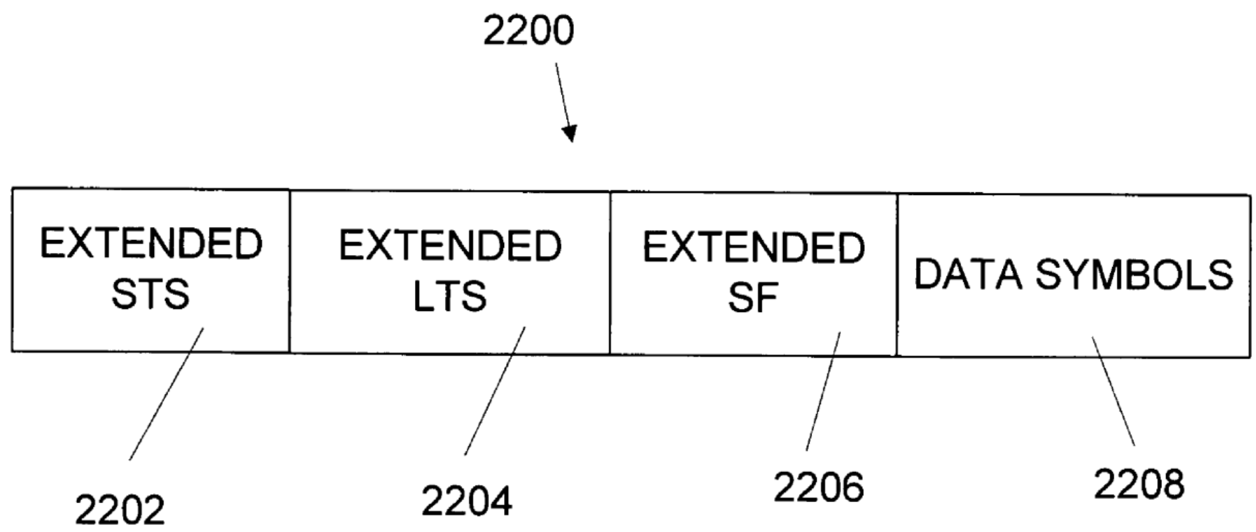
Claim 9 of the ’802 Patent	Prior Art Reference – Shearer
	modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then

Claim 9 of the '802 Patent	Prior Art Reference – Shearer
	shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals.

Claim 9 of the ’802 Patent	Prior Art Reference – Shearer
	See, e.g., Shearer at 8:17-9:24. FIG. 19 is a graph of each signal and its frequency vs. time relationship. Each signal's start time 1902 and end time 1904 is preferably substantially equivalent to eliminate problems with multiple signal acquisition and termination. These problems may include transmitting and receiving simultaneously. By occupying “both” channels at the same time, simultaneous transmitting and receiving is enabled. *See, e.g.*, Shearer at 10:31-38. An exemplary embodiment can support two types of packets, for example, for both 20 MHz and 40 MHz. The subcarrier alignment and receive detection methods detailed above apply to many nonlimiting packet types. One type of packet, as provided in FIG. 21, is a mixed-mode packet, which has the spectrally aligned legacy preamble/ header 2102, 2104, 2106, the extended header 2108, 2110, and data symbols 2112. A mixed-mode packet can occur for both 20 MHz and 40 MHz packets. In this case, it is important for legacy radios to see a legacy preamble/header. As such, a mixed-mode packet can start with a legacy preamble/ header 2102, 2104, 2106 and then follow with additional extended header/ preamble signal 2108, 2110. With mixed mode, the legacy radio receives what looks like a legacy packet, so it remains dormant through the following extended part. This allows for reception of legacy packets by legacy radios without disruption by an extended packet. This is sometimes referred to as spoofing a legacy radio. As provided in FIG. 22, a second type of packet 2200 is called Greenfield, which can occur for both 20 MHz and 40 MHz packets. In this case, it is not necessary to have a legacy radio process the packet. A Greenfield packet 2200 can be used in an environment (or time slot) where no legacy radios are receiving. As such, the packet begins immediately with an extended preamble/ header 2202, 2204, 2206, followed by data symbols 2208. *See, e.g.*, Shearer at 11:23-48.

Claim 9 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 19 *See, e.g.*, Shearer at Figure 19.

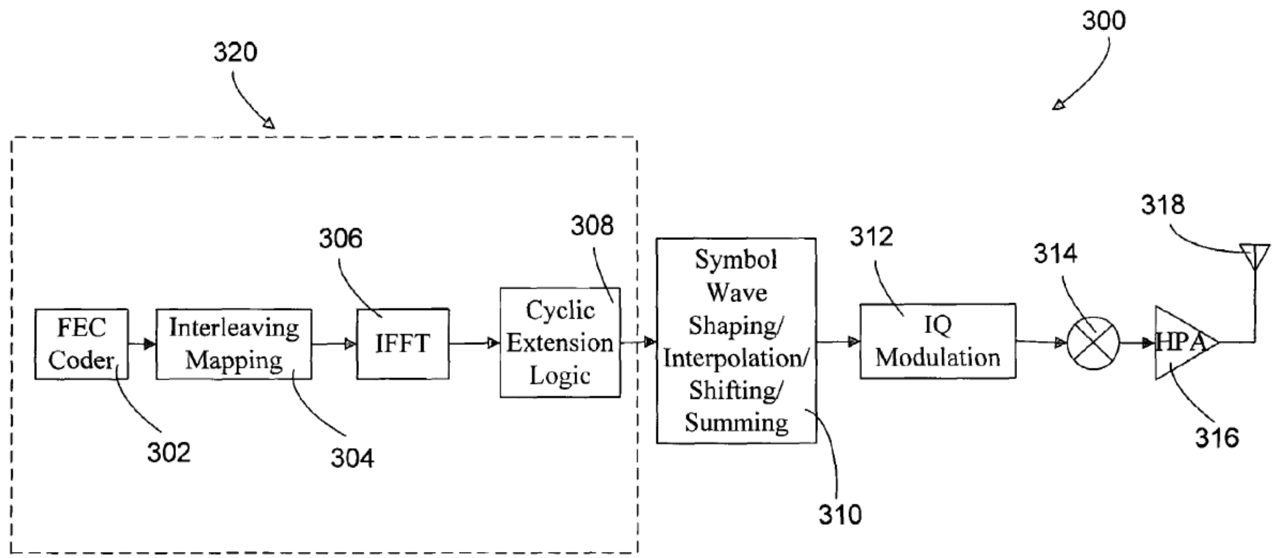
Claim 9 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 21 *See, e.g.*, Shearer at Figure 21.

Claim 9 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 22 *See, e.g.*, Shearer at Figure 22. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further

Claim 9 of the ’802 Patent	Prior Art Reference – Shearer
	motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
[10.1] A method of transmitting information in a wireless communication channel comprising:	To the extent the preamble is limiting, Shearer discloses “A method of transmitting information in a wireless communication channel comprising.” See, e.g.: Disclosed herein are various embodiments of methods, systems, and apparatus for increasing packet generation in a digital communication system. In one exemplary method embodiment, subcarriers are added to a packet in a wireless local area network transmission to increase the data rate. *See, e.g.*, Shearer at Abstract. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. *See, e.g.*, Shearer at 1:31-38. 802.11 is directed to wireless LANs, and in particular specifies the MAC and the PHY layers. These layers are intended to correspond closely to the two lowest layers of a system based on the ISO Basic Reference Model of OSI, i.e., the data link layer and the physical layer. FIG. 1 shows a diagrammatic representation of an open systems interconnection (OSI) layered model 100 developed by the International Organization for Standards (ISO) for describing the exchange of information between layers in communication networks. The OSI layered model 100 is particularly useful for separating the technological functions of each layer, and thereby facilitating the modification or update of a given layer without detrimentally impacting on the functions of neighboring layers.

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	See, e.g., Shearer at 3:61-4:7. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. *See, e.g.*, Shearer at 4:62-5:4. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.2] receiving a first digital signal comprising first data to be transmitted;	Shearer discloses “receiving a first digital signal comprising first data to be transmitted.” See, e.g.:

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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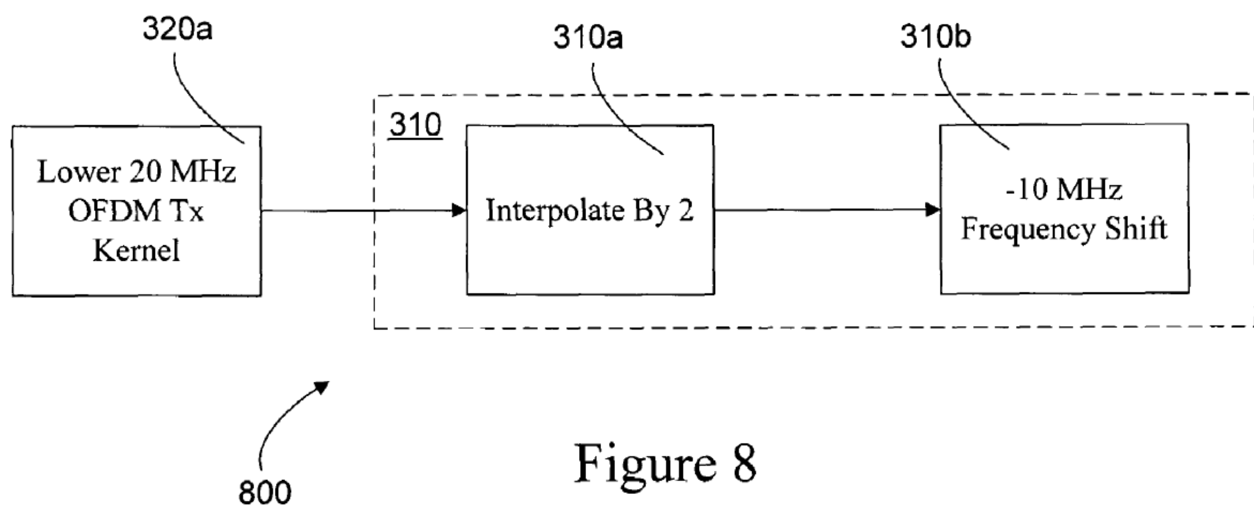
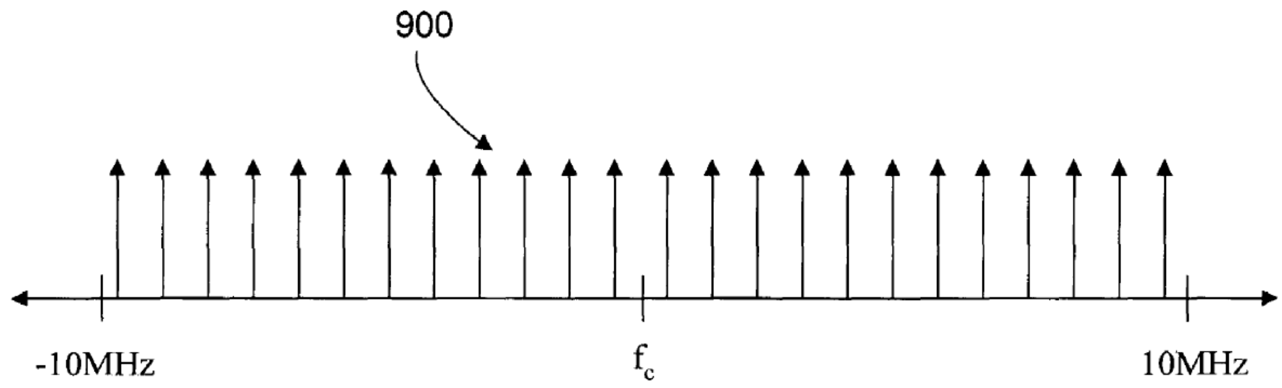
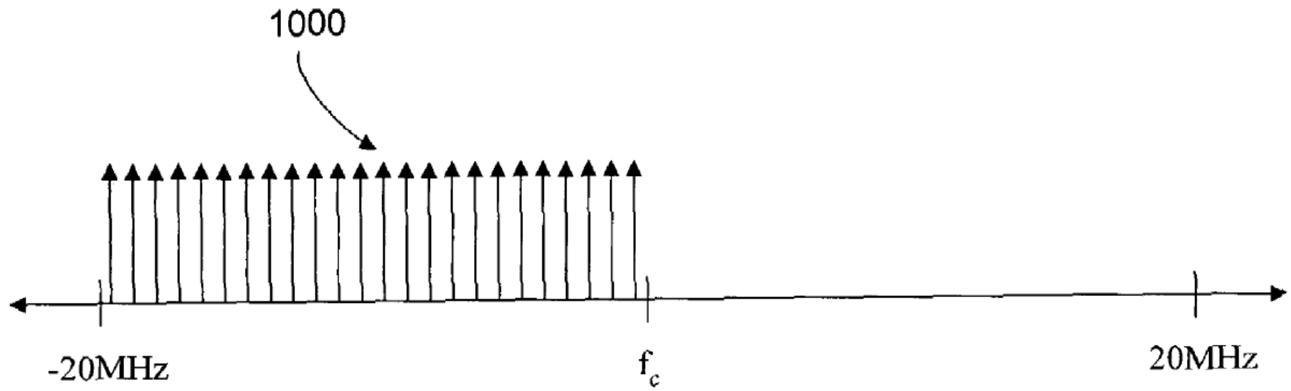
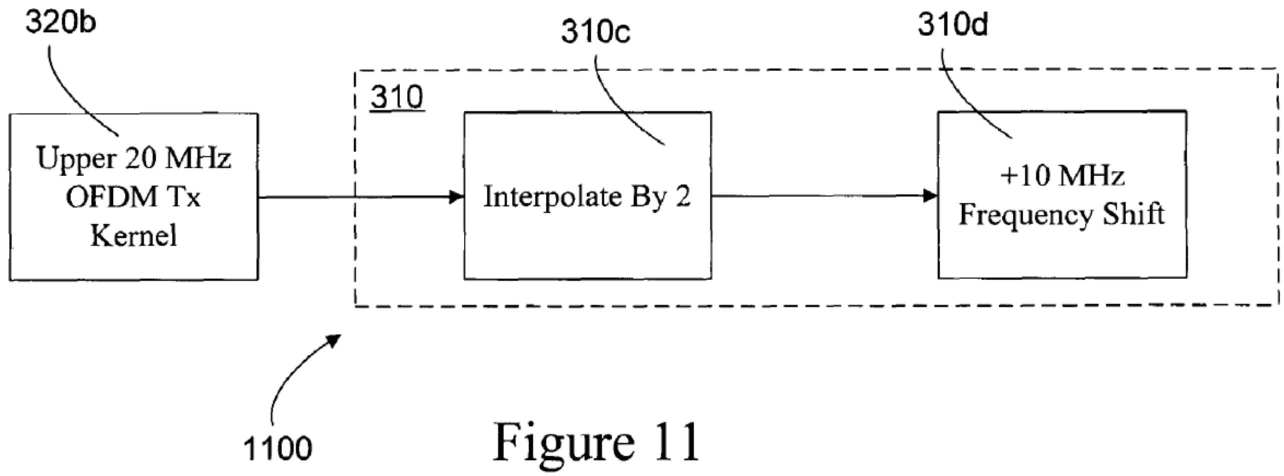
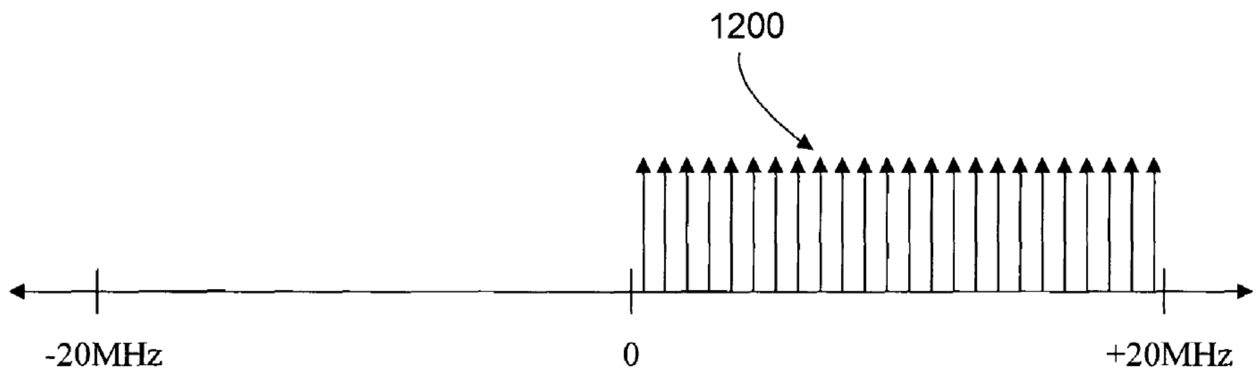
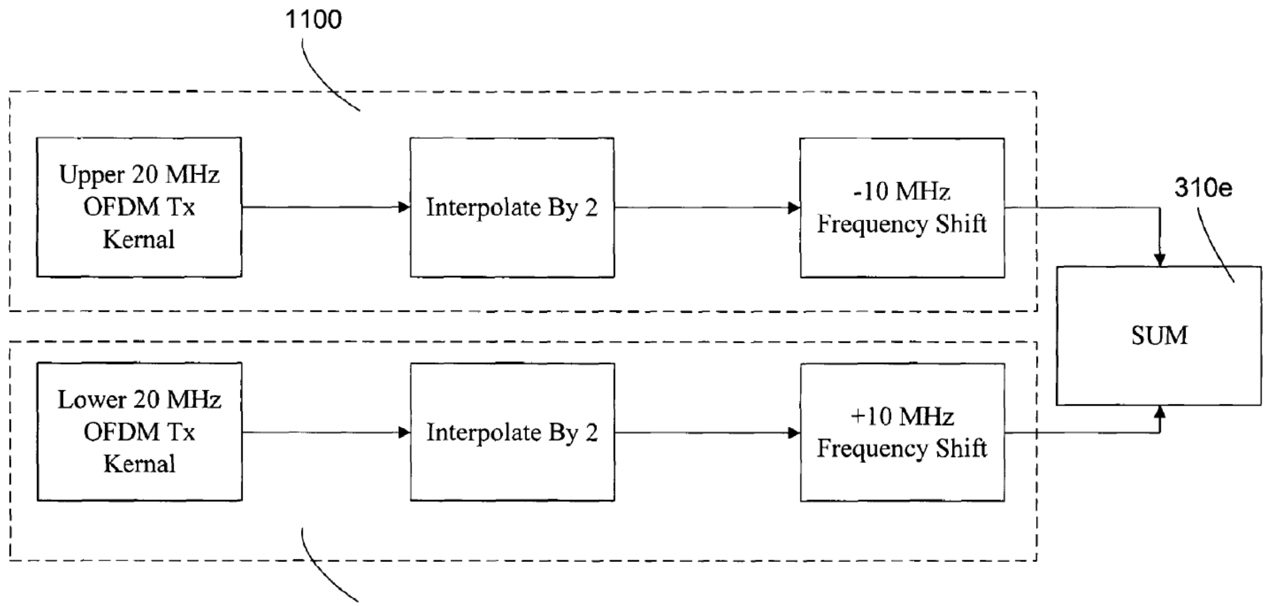
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

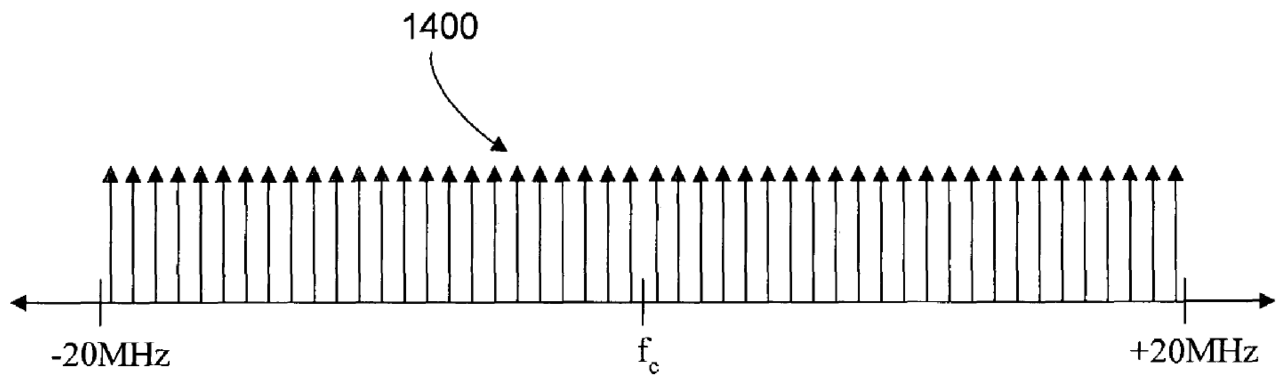
Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See, e.g.*, Shearer at Figure 9.

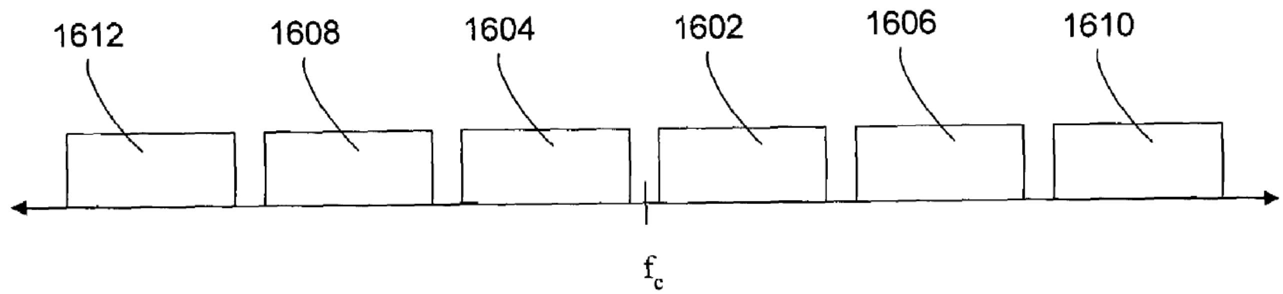
Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See, e.g.*, Shearer at Figure 10.

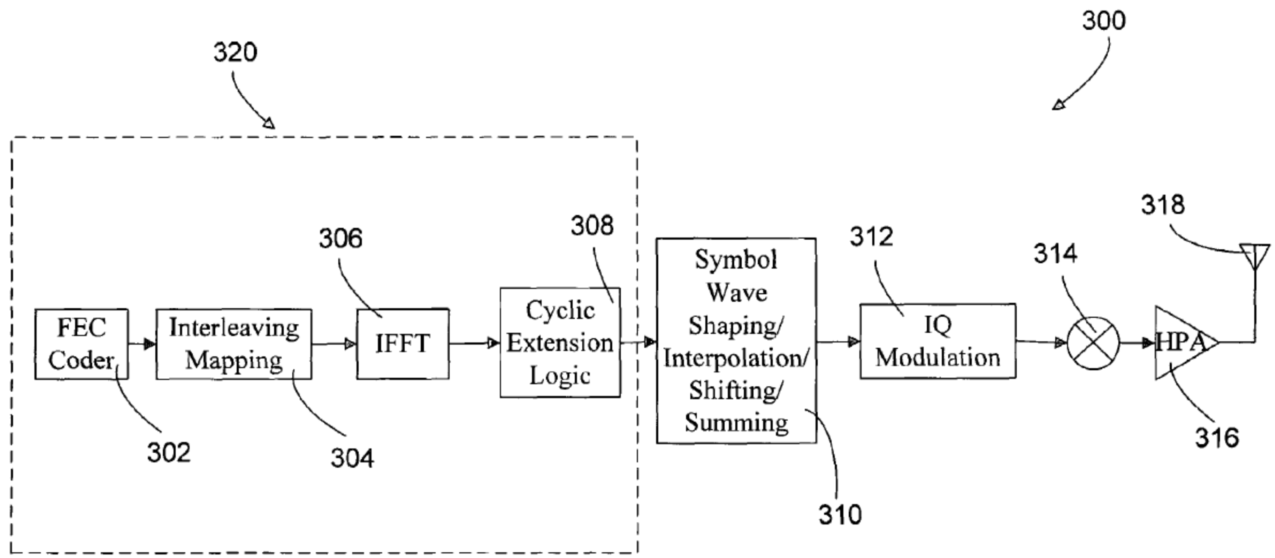
Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

Claim 10 of the '802 Patent	**Prior Art Reference – Shearer**
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.3] receiving a second digital signal comprising second data to be transmitted;	Shearer discloses "receiving a second digital signal comprising second data to be transmitted." See, e.g.:

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 ("802.11") is set out in "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications" and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate "dead spots," and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See*, *e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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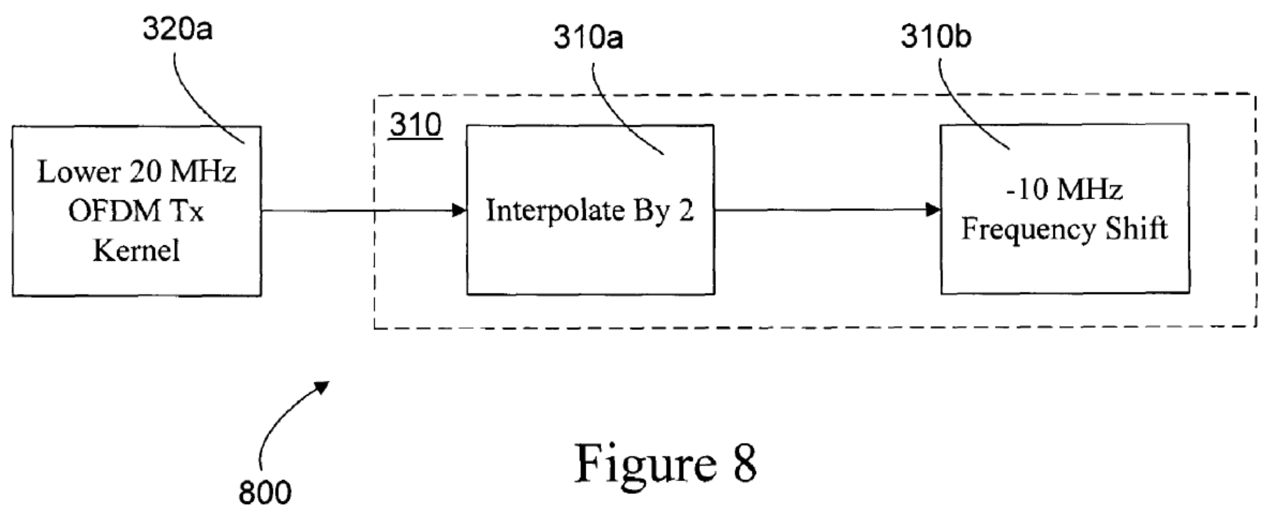
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

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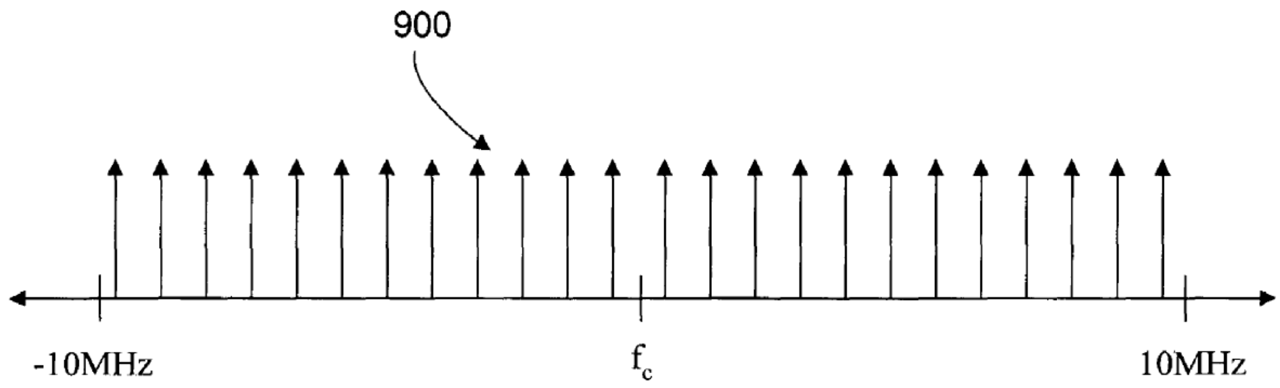
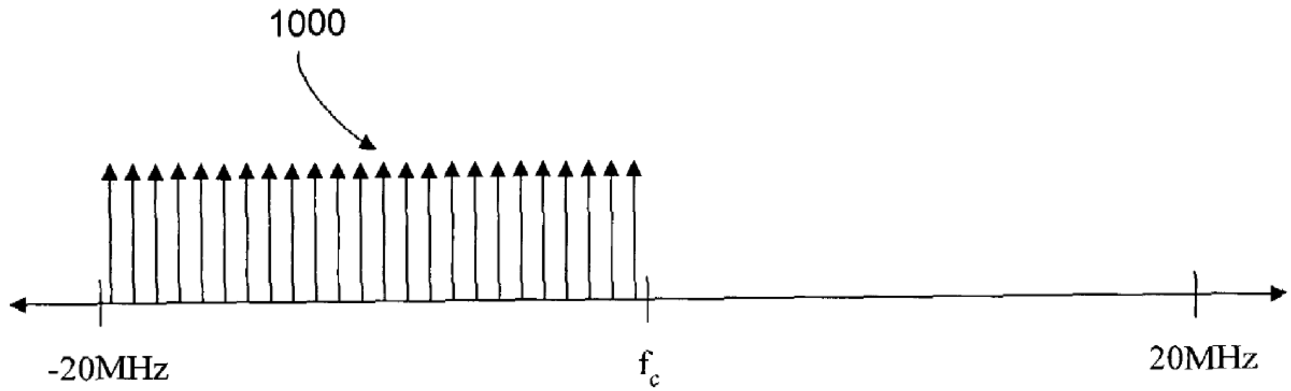
	 Figure 9 *See, e.g.*, Shearer at Figure 9.

<table>
<tr><th>Claim 10 of the ’802 Patent</th><th>Prior Art Reference – Shearer</th></tr>
<tr><td></td><td>
Figure 10

See, e.g., Shearer at Figure 10.</td></tr>
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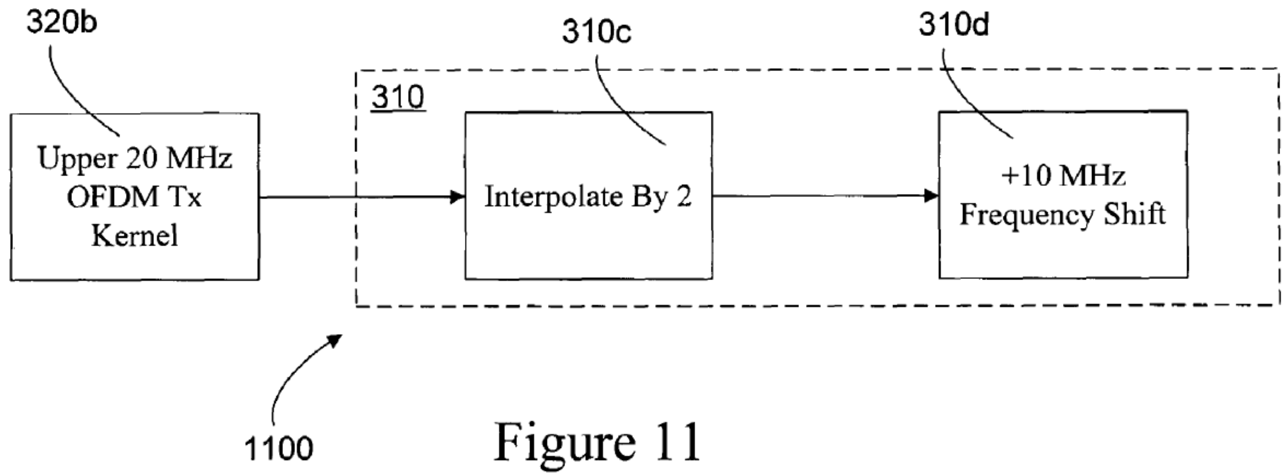
Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

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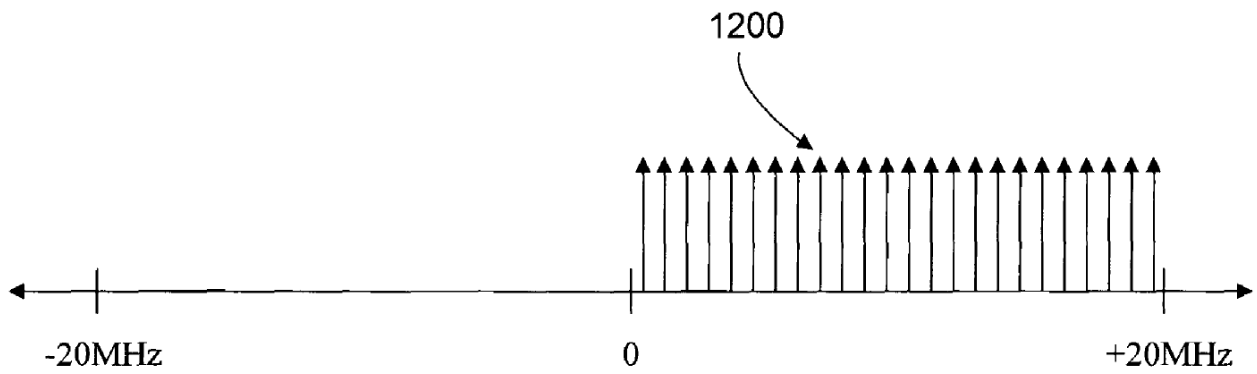
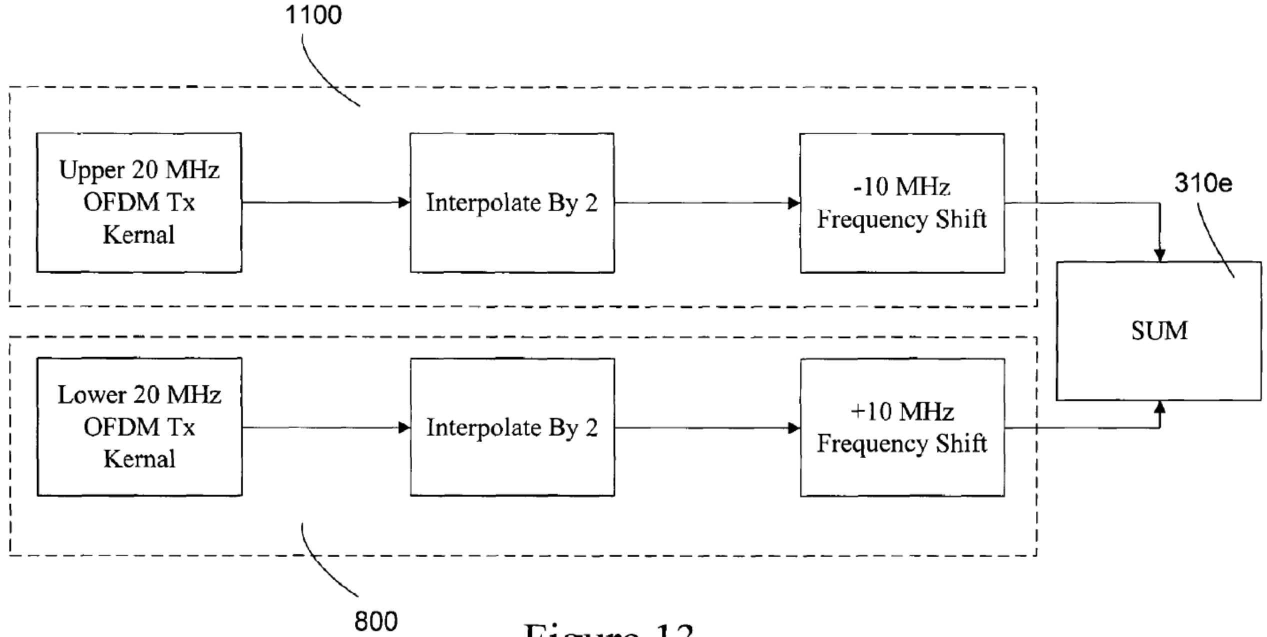
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

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	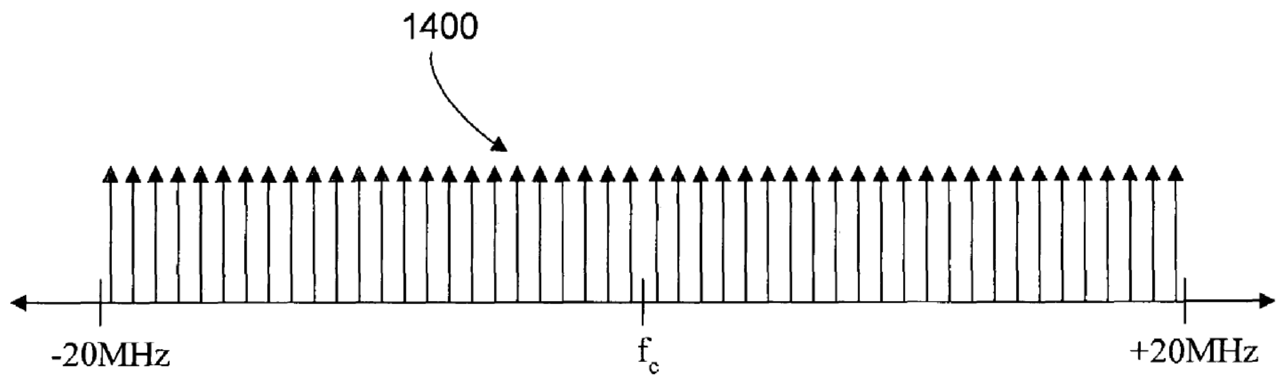 Figure 14 *See, e.g.*, Shearer at Figure 14.

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	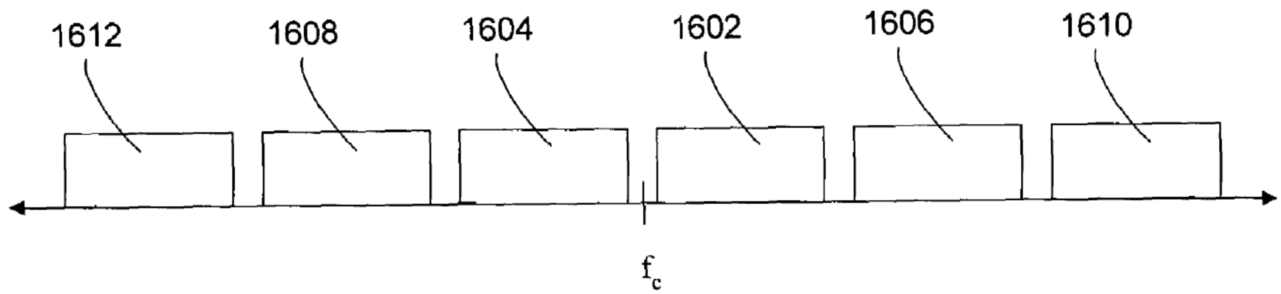 Figure 16 *See*, *e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.4] converting the first digital signal into a first analog signal using a first digital-to-analog converter, the first analog signal carrying the first data across a first frequency range;.	Shearer discloses "converting the first digital signal into a first analog signal using a first digital-to-analog converter, the first analog signal carrying the first data across a first frequency range." See, e.g.:

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	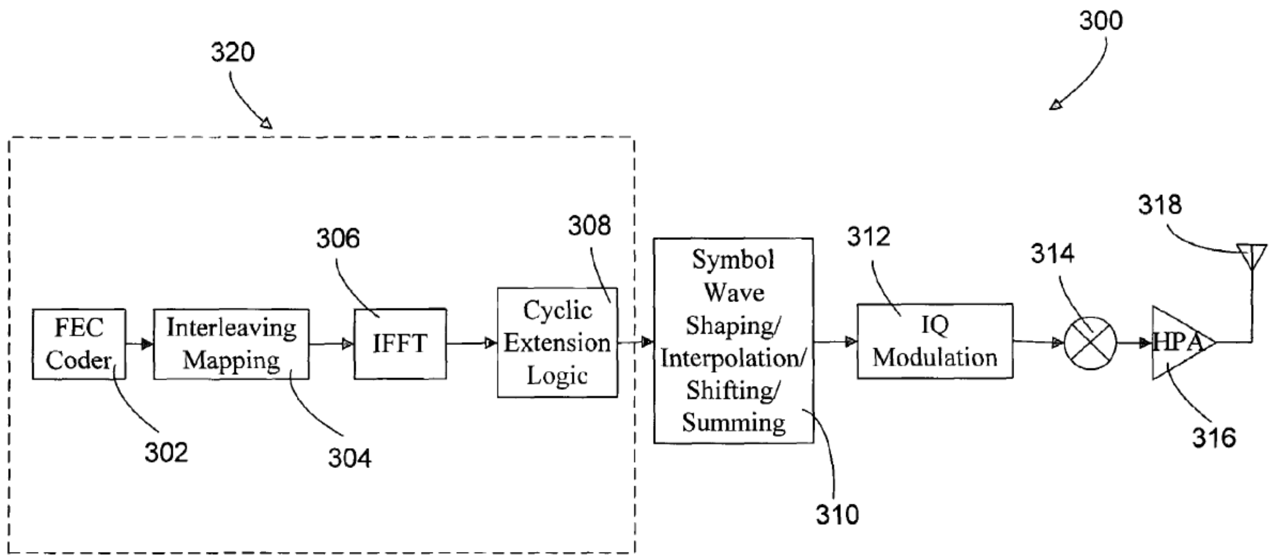 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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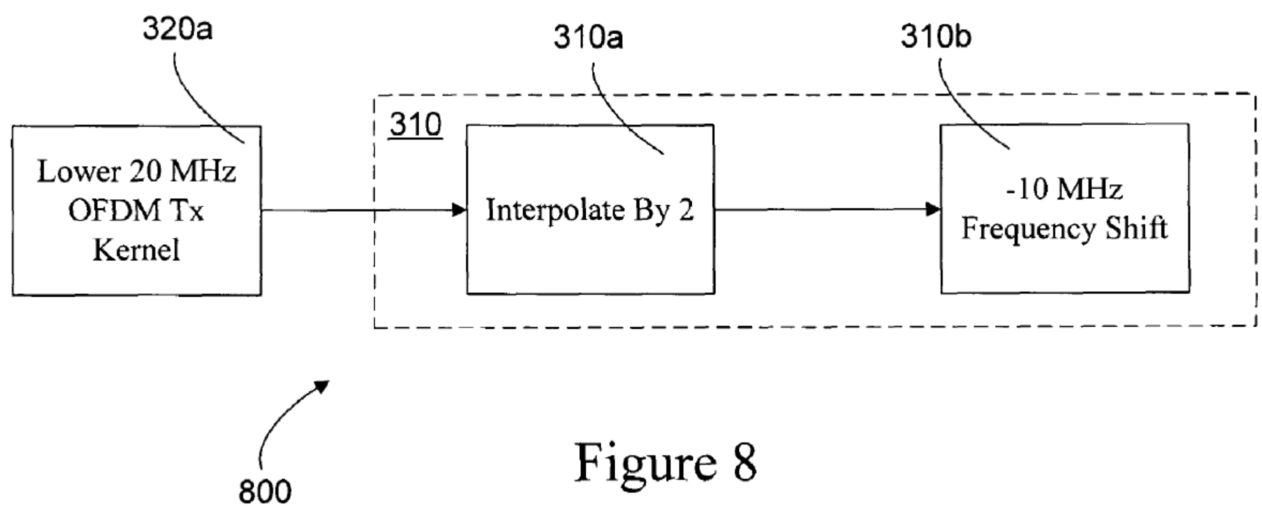
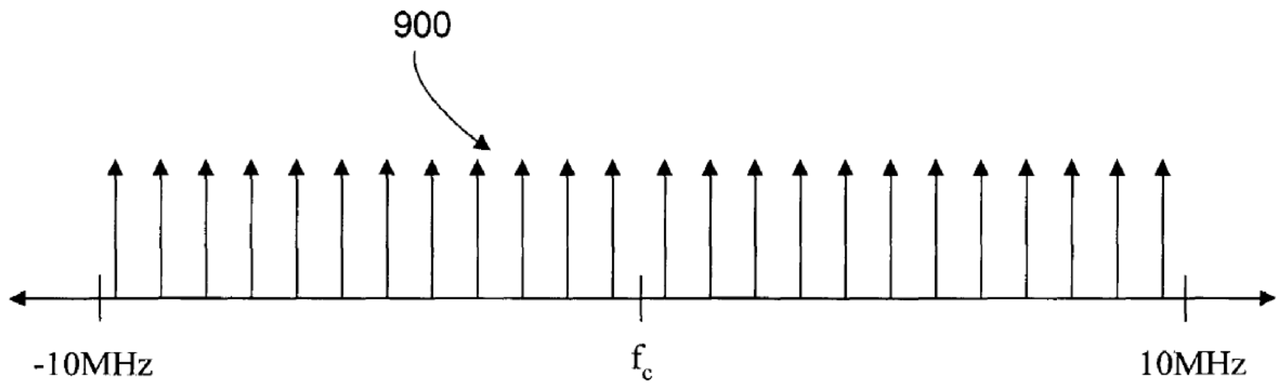
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See, e.g.*, Shearer at Figure 9.

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	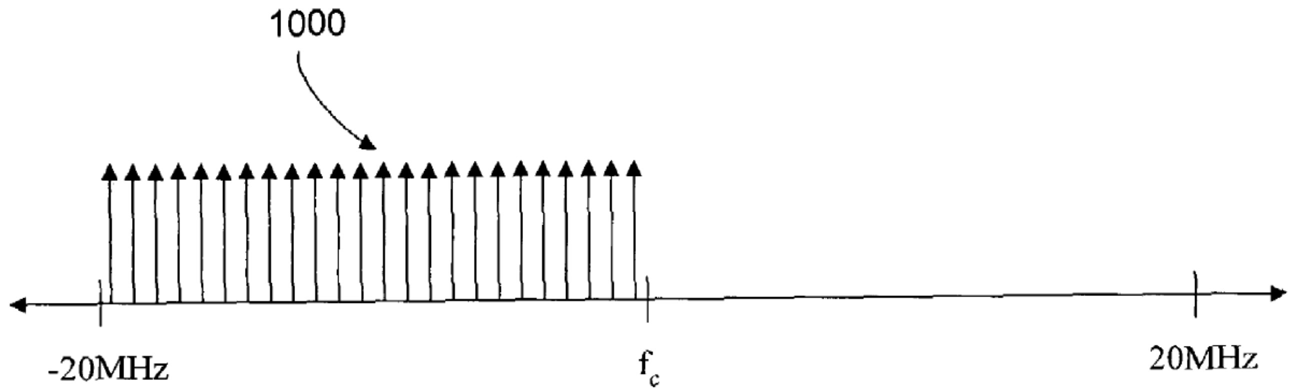 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

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	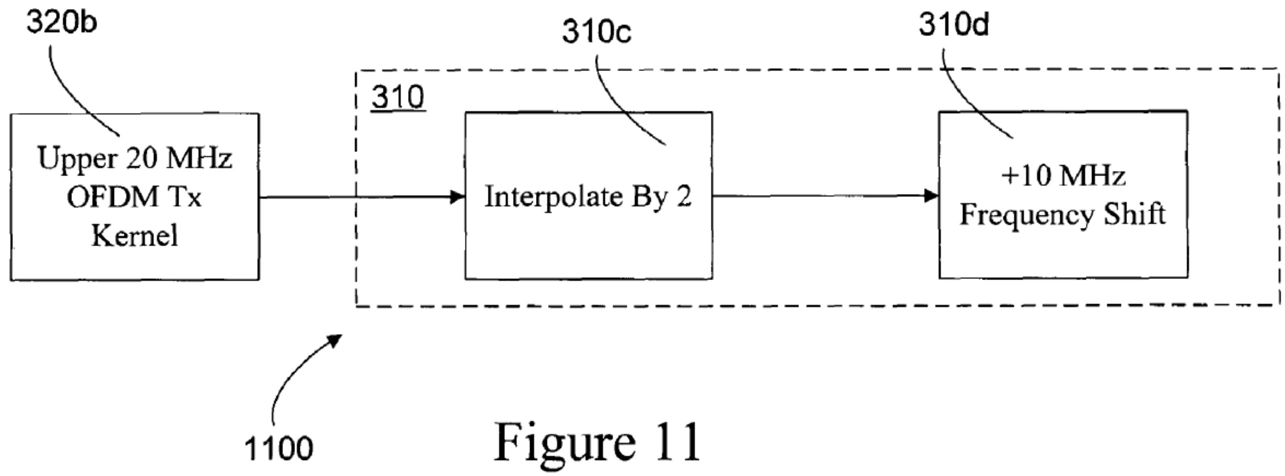 Figure 11 *See, e.g.*, Shearer at Figure 11.

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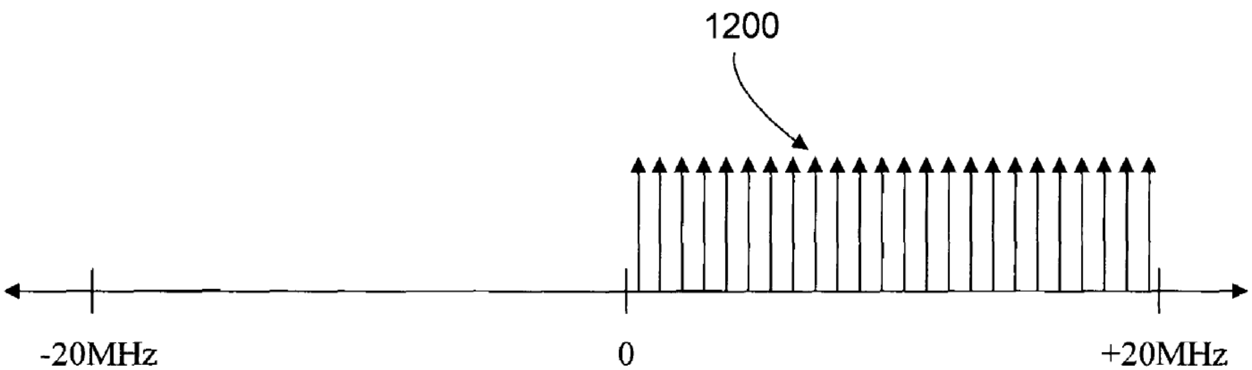
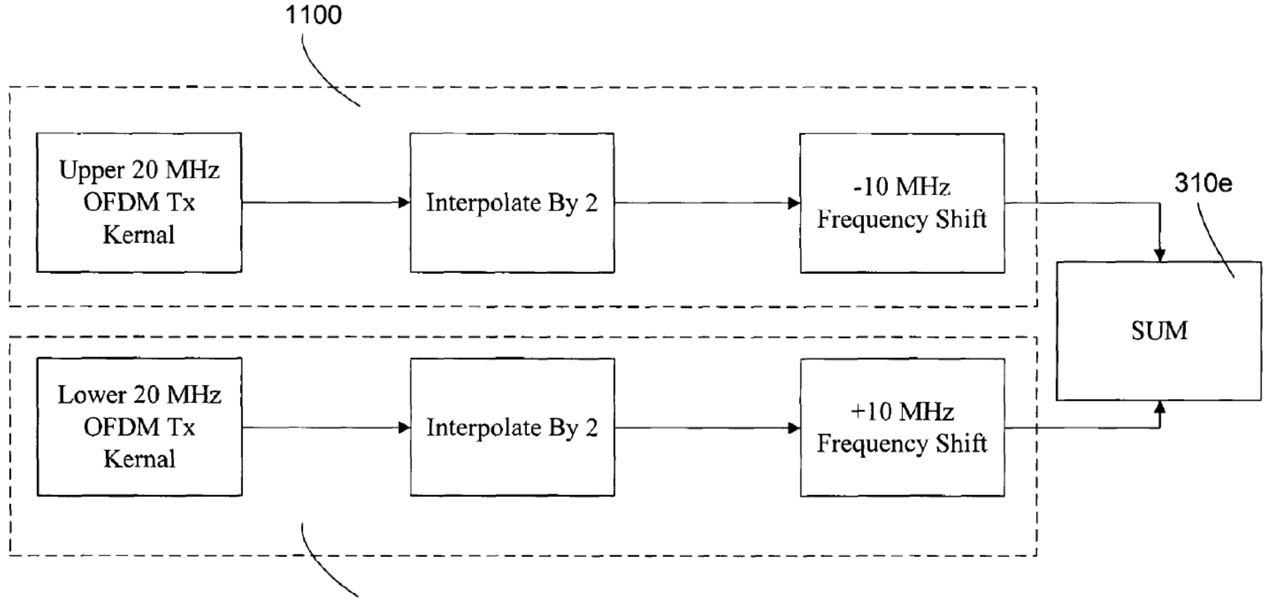
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

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	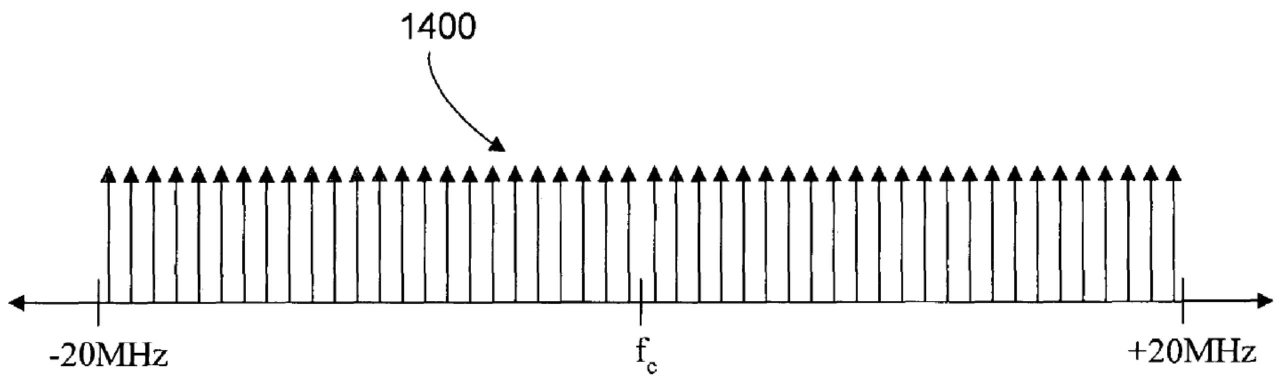 Figure 14 *See, e.g.*, Shearer at Figure 14.

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	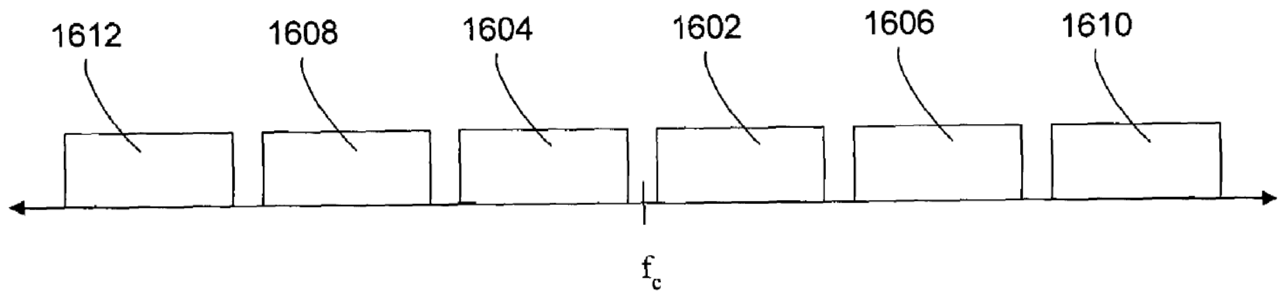 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.5] converting the second digital signal into a second analog signal using a second digital-to-analog converter, the second analog signal carrying the second data across a second frequency range;	Shearer discloses "converting the second digital signal into a second analog signal using a second digital-to-analog converter, the second analog signal carrying the second data across a second frequency range." See, e.g.:

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	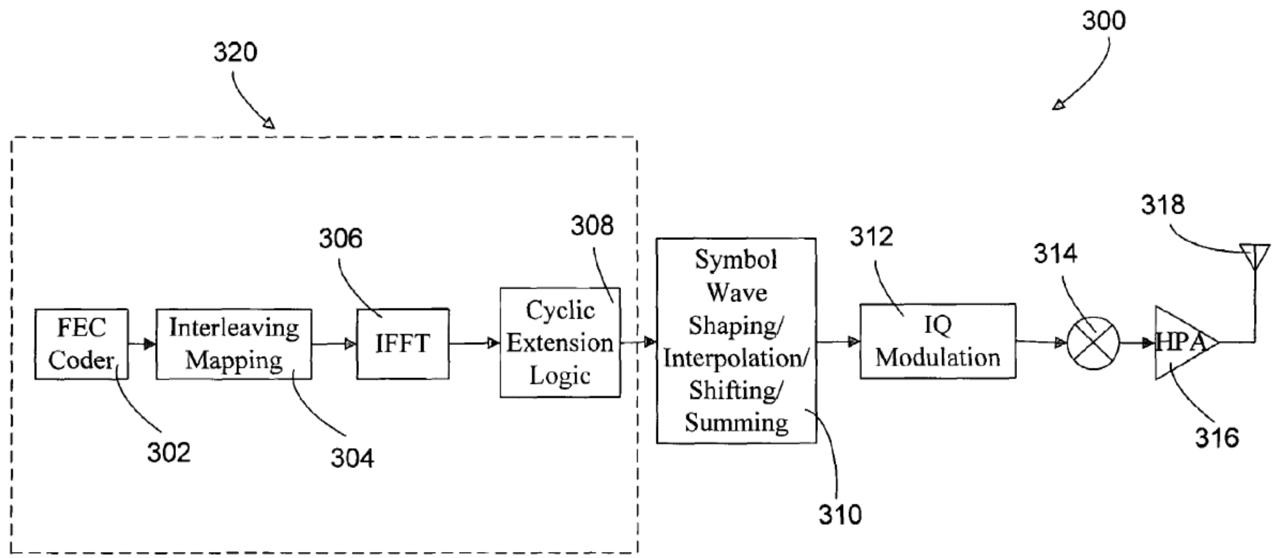 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See*, *e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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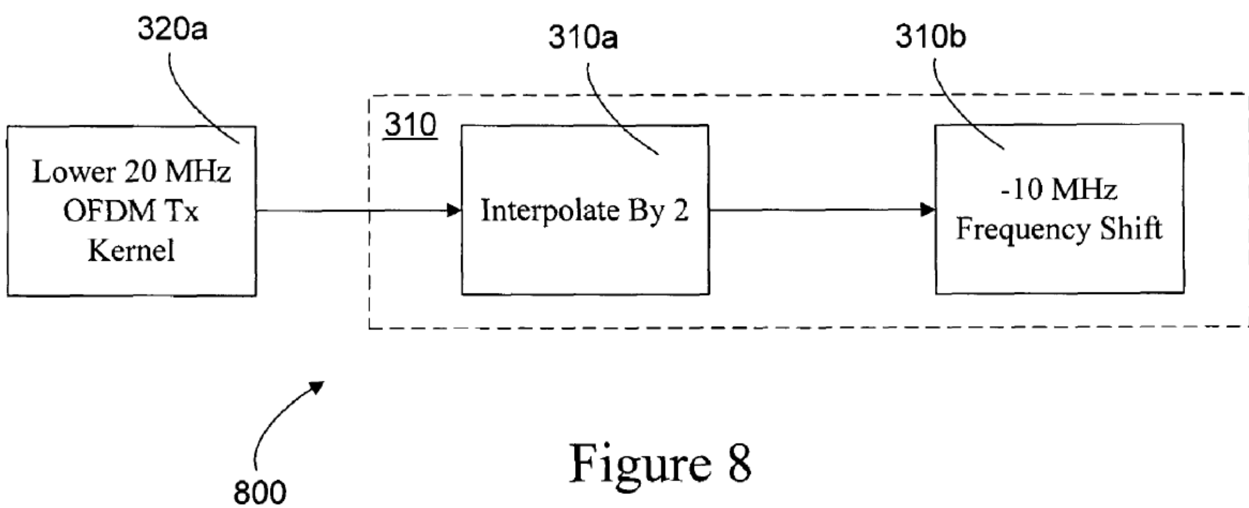
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

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	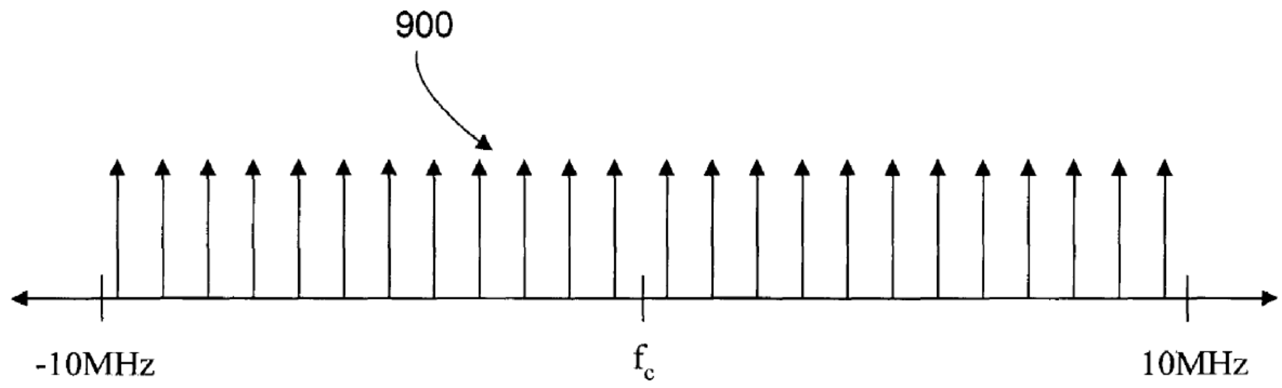 Figure 9 *See, e.g.*, Shearer at Figure 9.

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	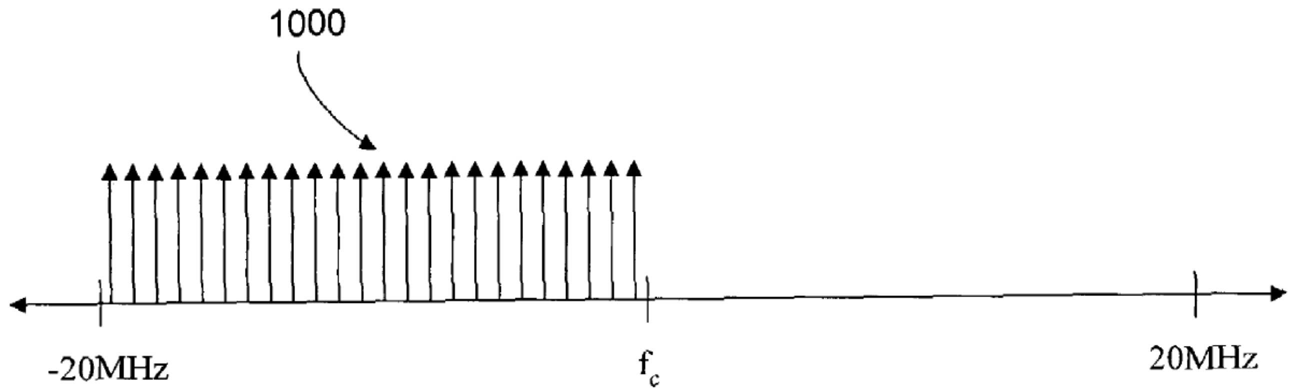 Figure 10 *See, e.g.*, Shearer at Figure 10.

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	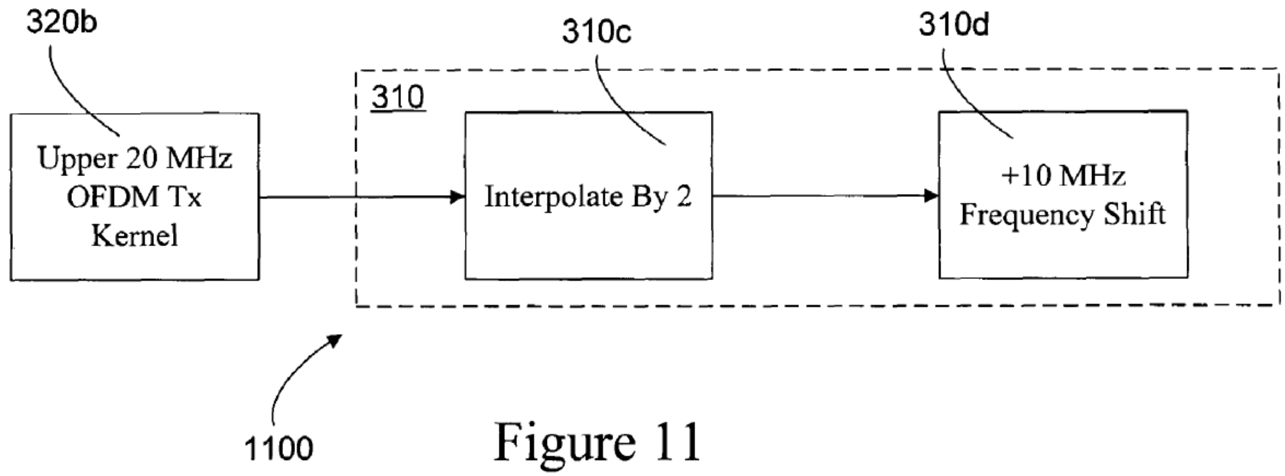 Figure 11 *See, e.g.*, Shearer at Figure 11.

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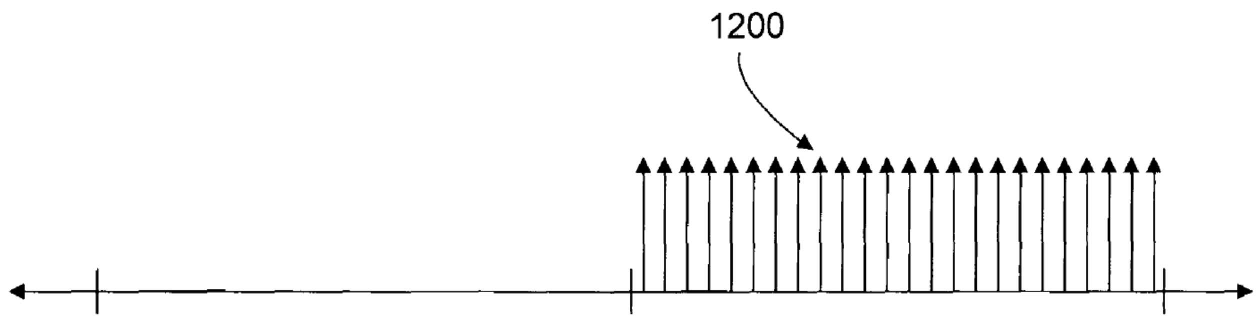
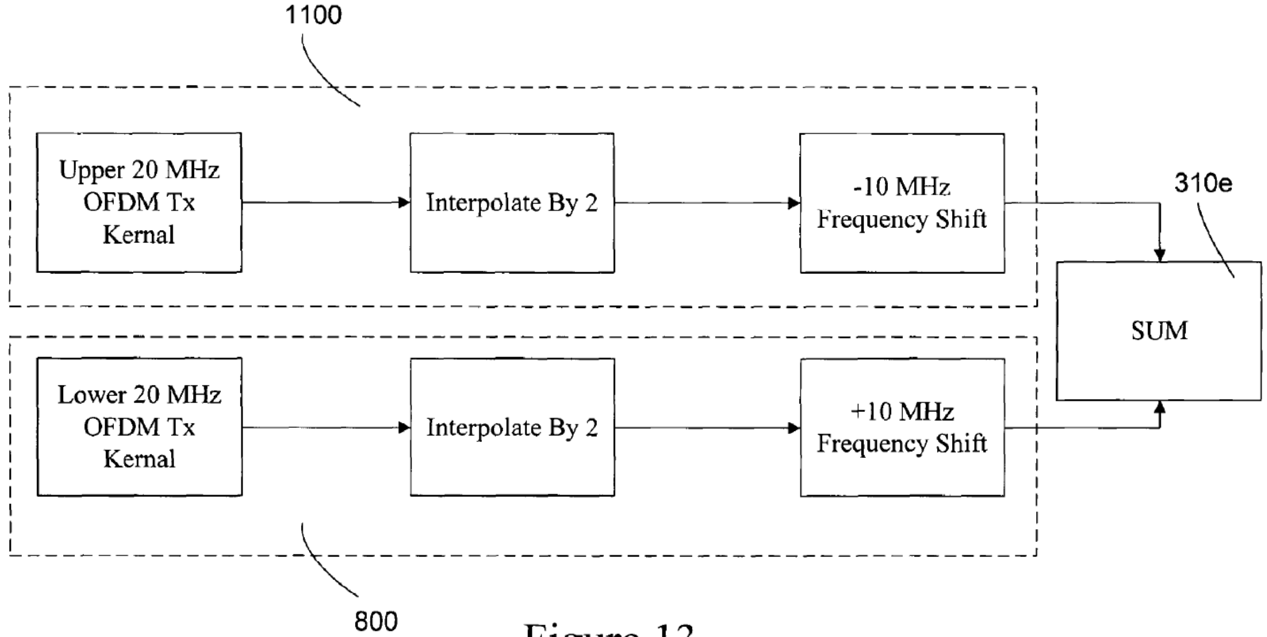
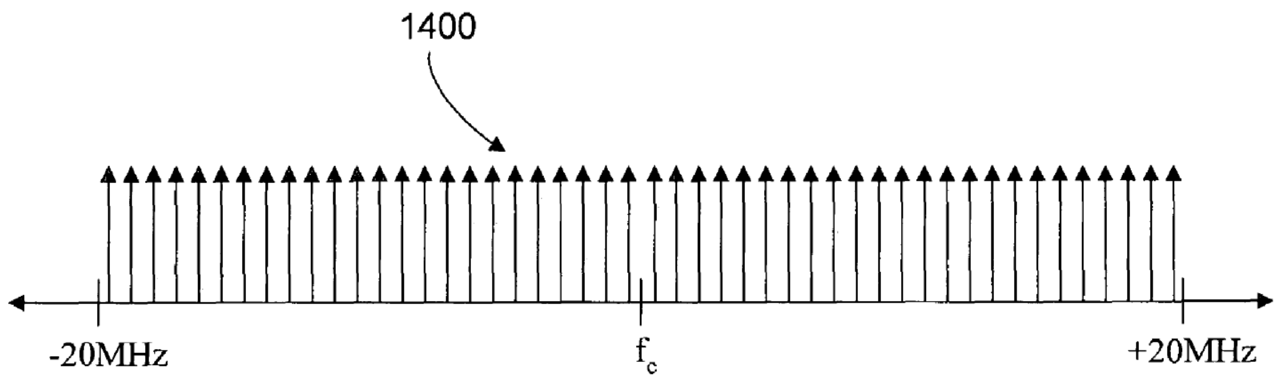
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

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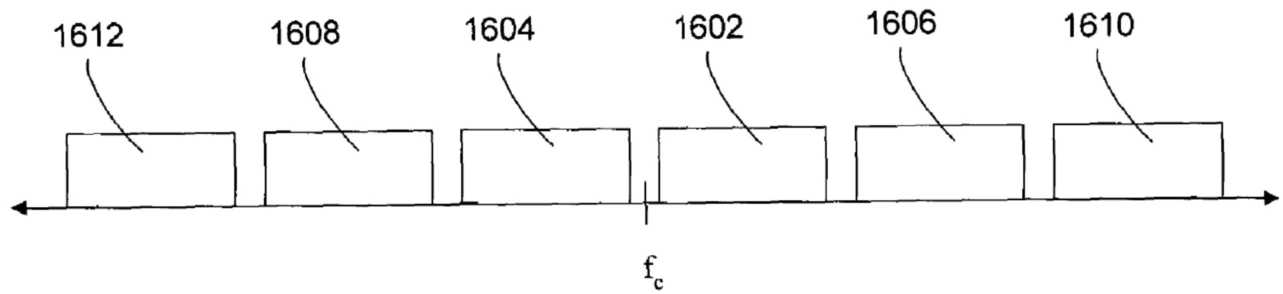
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.6] up-converting the first analog signal to a first RF center frequency to produce a first up-converted analog signal, wherein the first up-converted analog signal comprises a first up-converted frequency range from the first	Shearer discloses "up-converting the first analog signal to a first RF center frequency to produce a first up-converted analog signal, wherein the first up-converted analog signal comprises a first up-converted frequency range from the first RF center frequency minus one-half the first frequency range to the first RF center frequency plus one-half the first frequency range." See, e.g.:

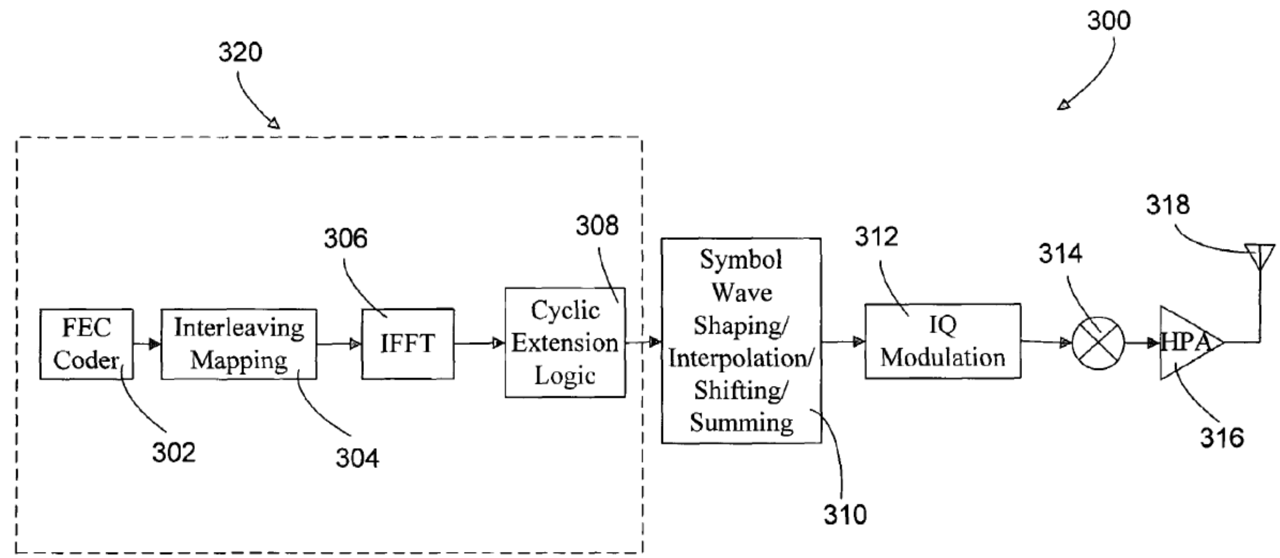
<table>
<tr><th>Claim 10 of the ’802 Patent</th><th>Prior Art Reference – Shearer</th></tr>
<tr><td>RF center frequency minus one-half the first frequency range to the first RF center frequency plus one-half the first frequency range;</td><td>

Figure 3

See, e.g., Shearer at Figure 3.

A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems.

Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within</td></tr>
</table>

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See*, *e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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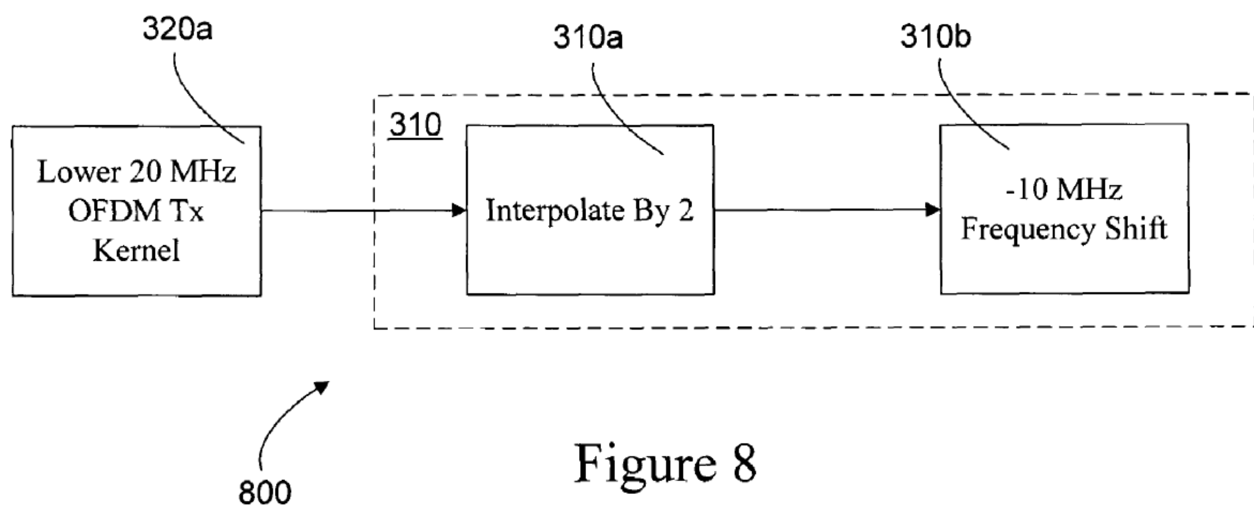
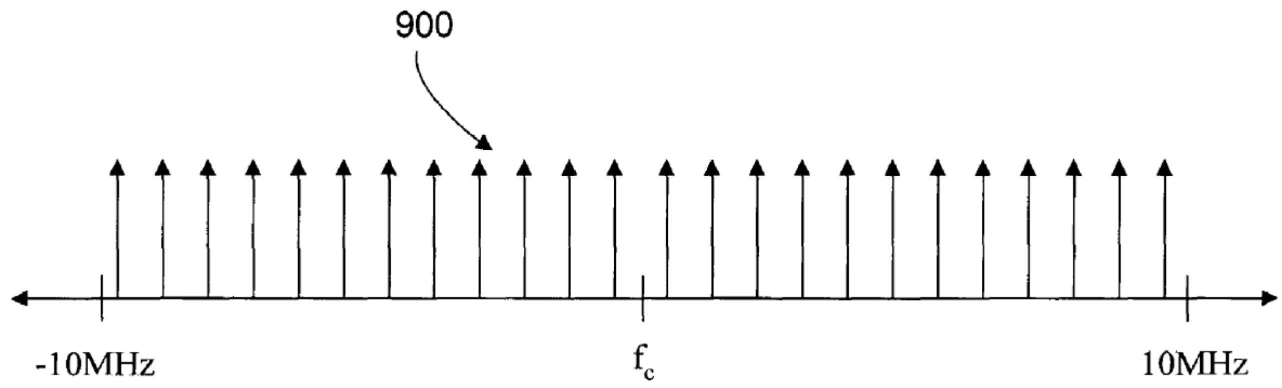
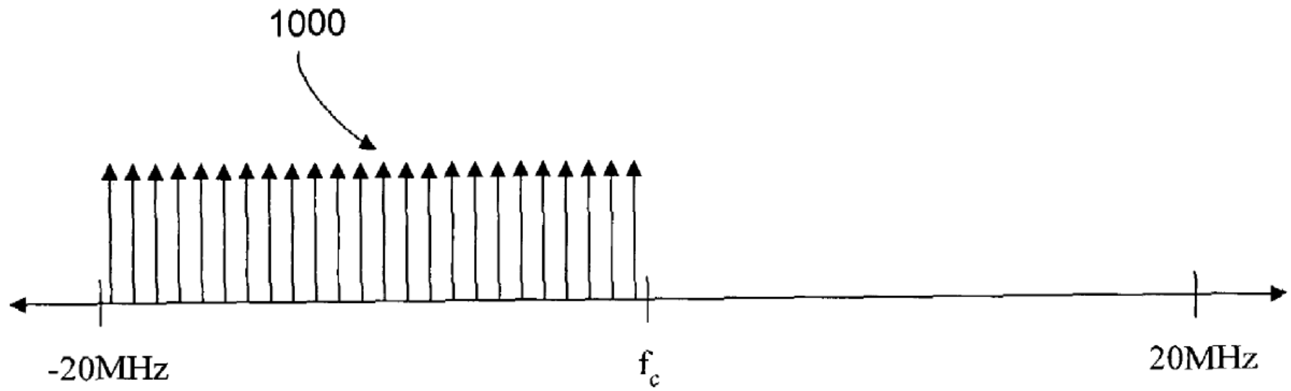
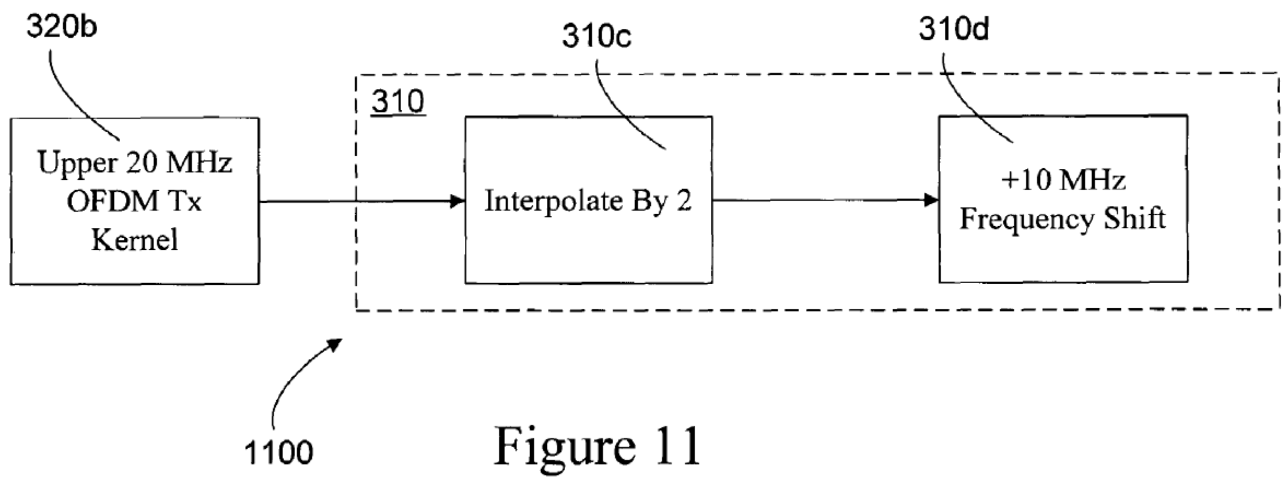
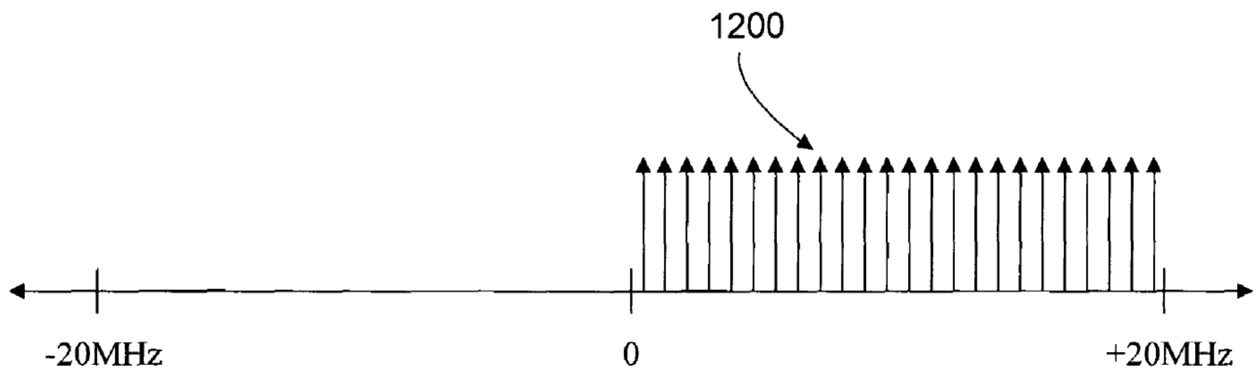
	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

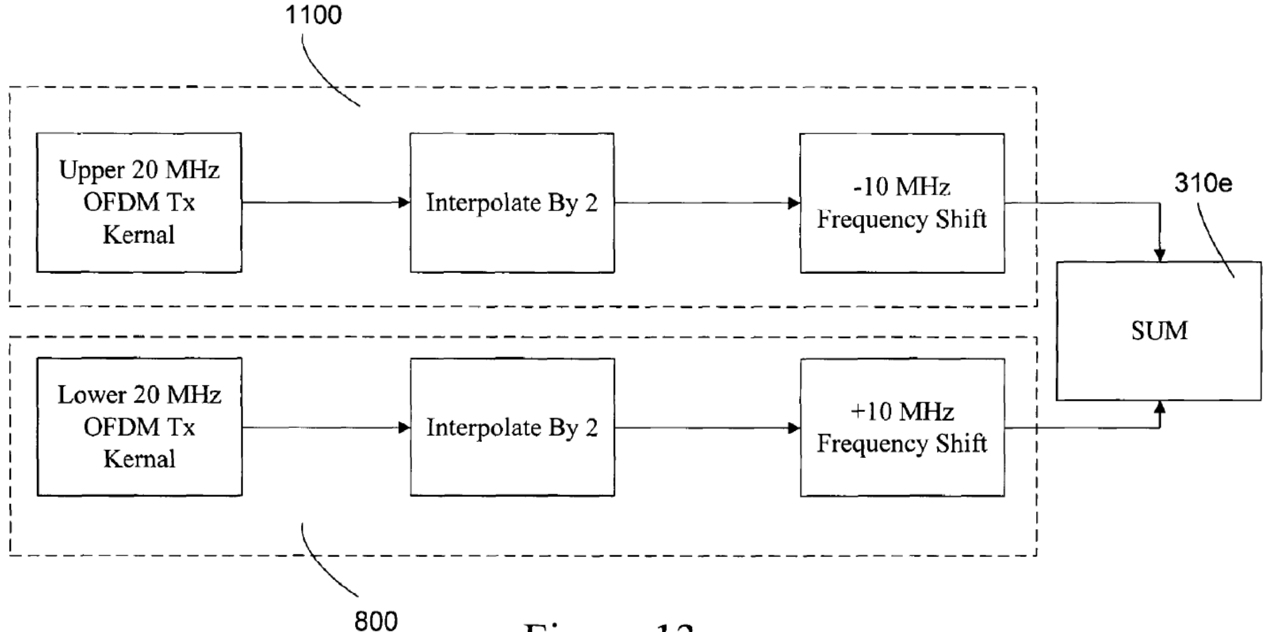
Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

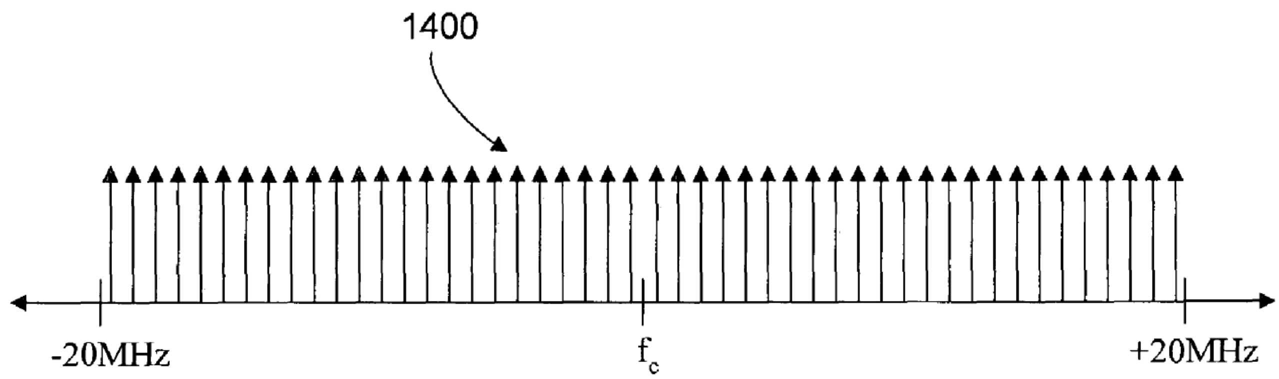
Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See, e.g.*, Shearer at Figure 9.

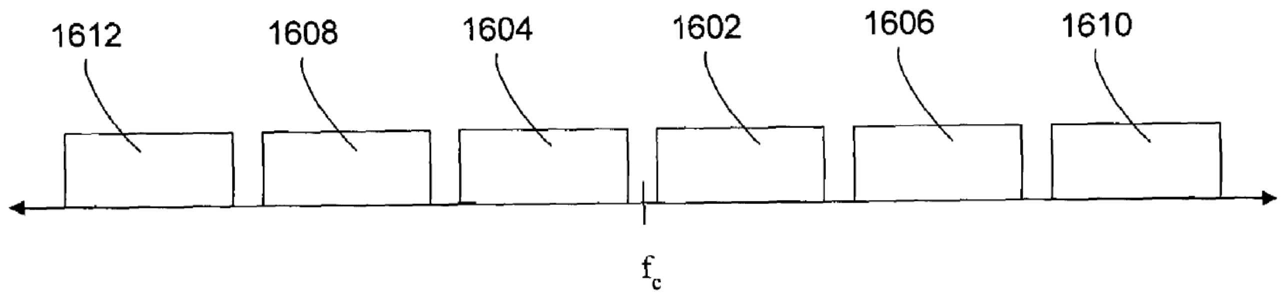
Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See, e.g.*, Shearer at Figure 10.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.7] up-converting the second analog signal to a second RF center frequency greater than the first center RF frequency to produce a second up-converted analog signal, wherein the second up-converted analog signal	Shearer discloses "up-converting the second analog signal to a second RF center frequency greater than the first center RF frequency to produce a second up-converted analog signal, wherein the second up-converted analog signal comprises a second up-converted frequency range from the second RF center frequency minus one-half the second frequency range to the second RF center frequency plus one-half the second frequency range, and wherein a frequency difference between the first RF center frequency and the second RF center frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range." See, e.g.:

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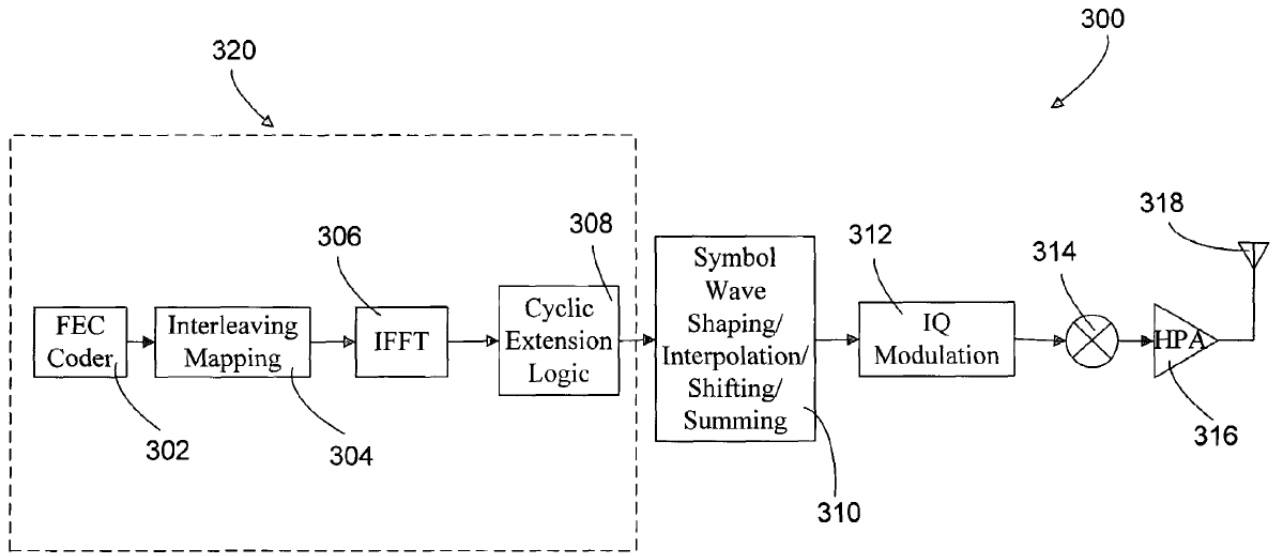
comprises a second up-converted frequency range from the second RF center frequency minus one-half the second frequency range to the second RF center frequency plus one-half the second frequency range, and wherein a frequency difference between the first RF center frequency and the second RF center frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range;	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of

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	the terminals are capable of communicating with at least two of the access points when located within a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308.

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	During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC) code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz

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	channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A

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	lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are

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	received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for

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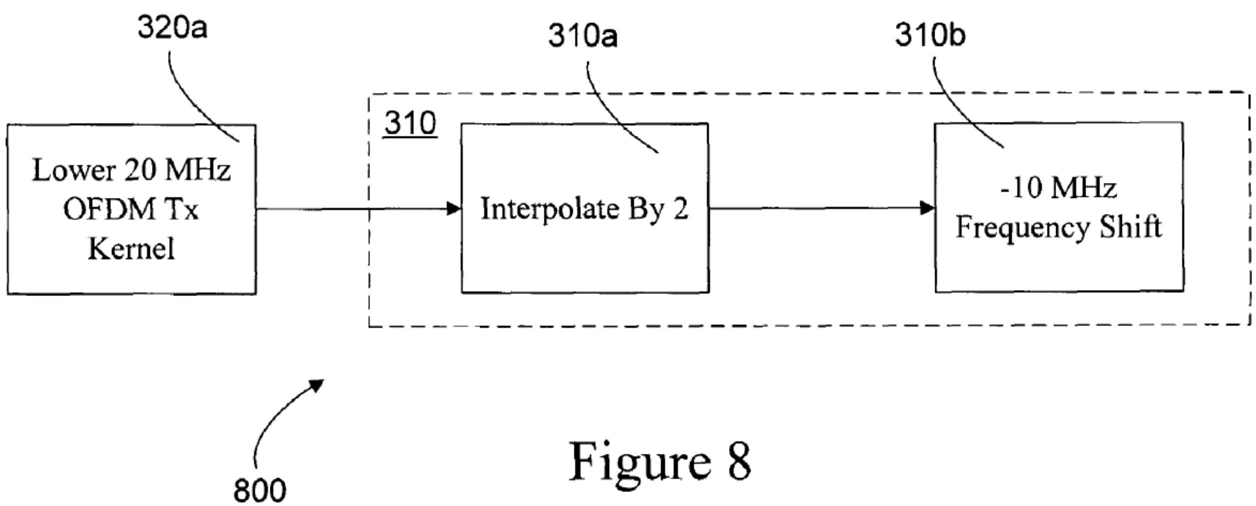
	transmission. This process is applicable for any even number of input signals. Each simultaneous input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

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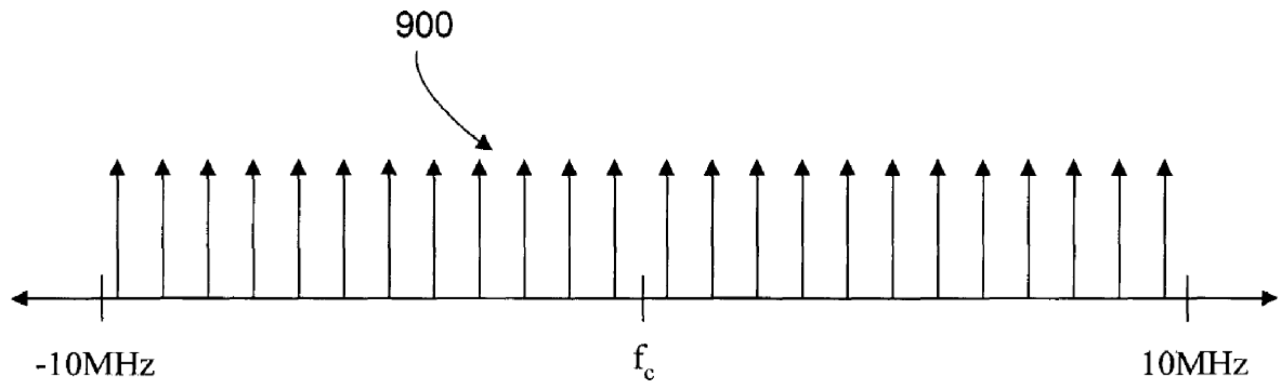
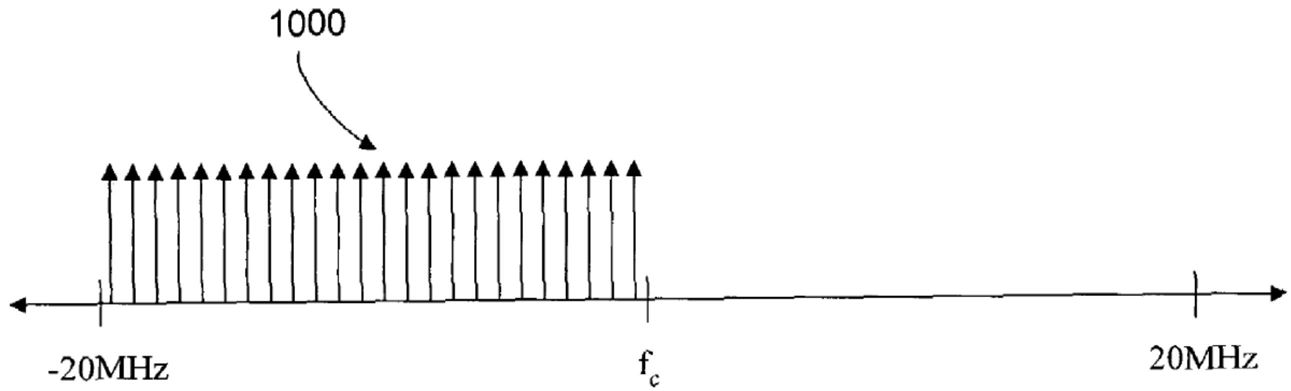
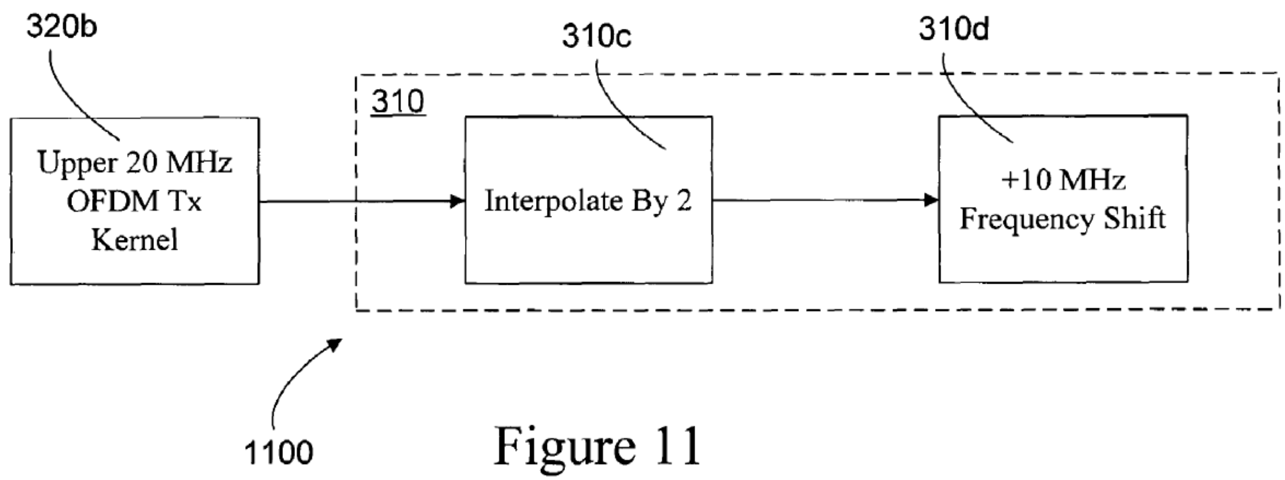
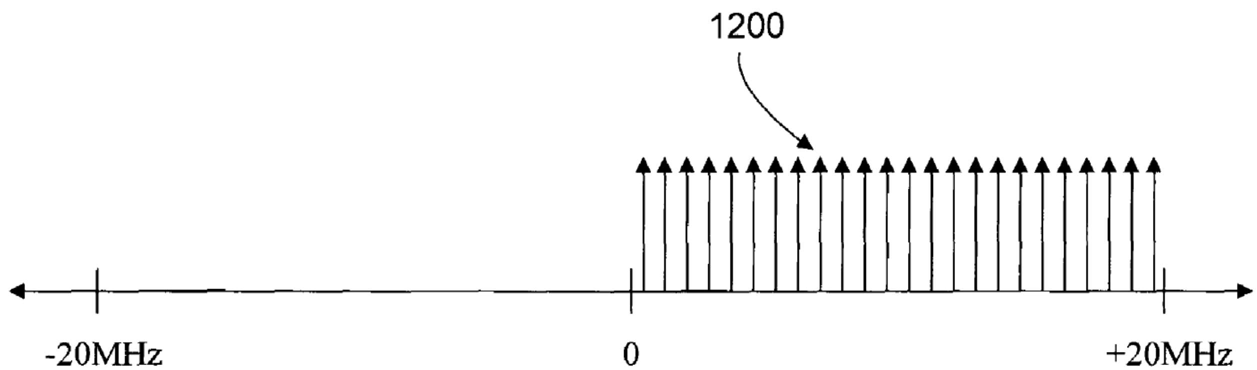
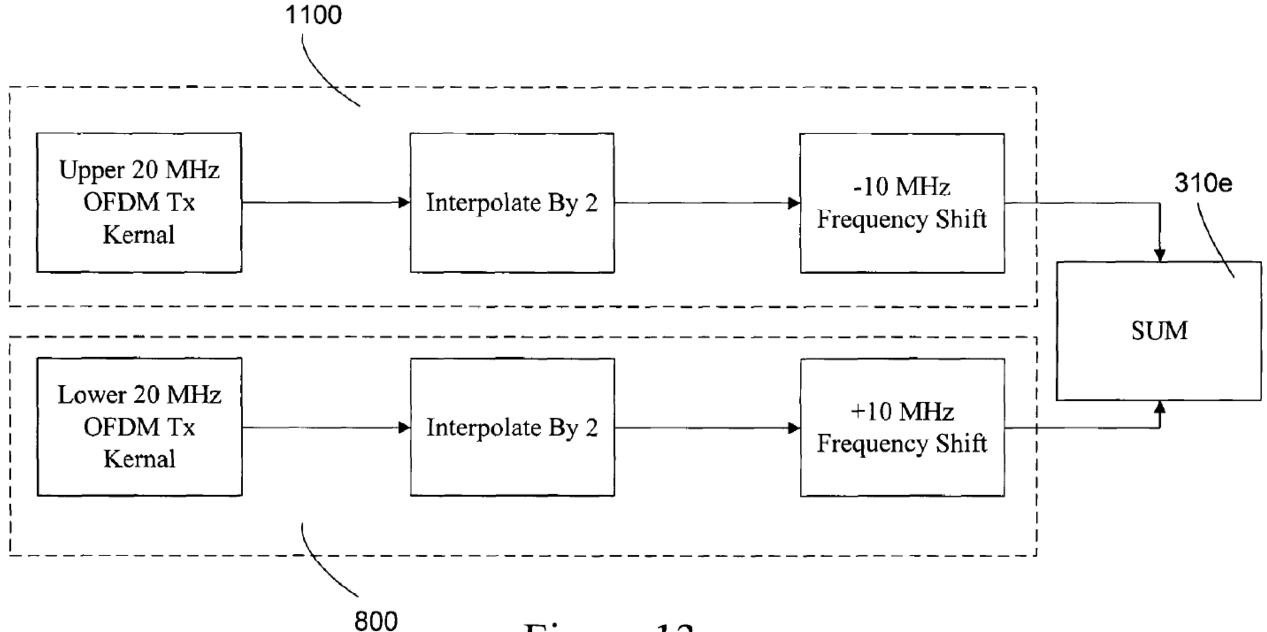
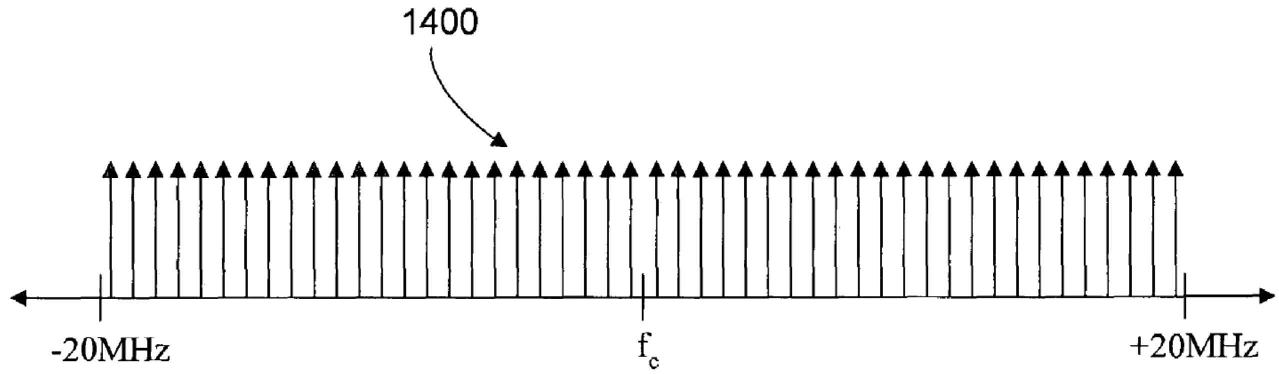
	 Figure 9 *See*, *e.g.*, Shearer at Figure 9.

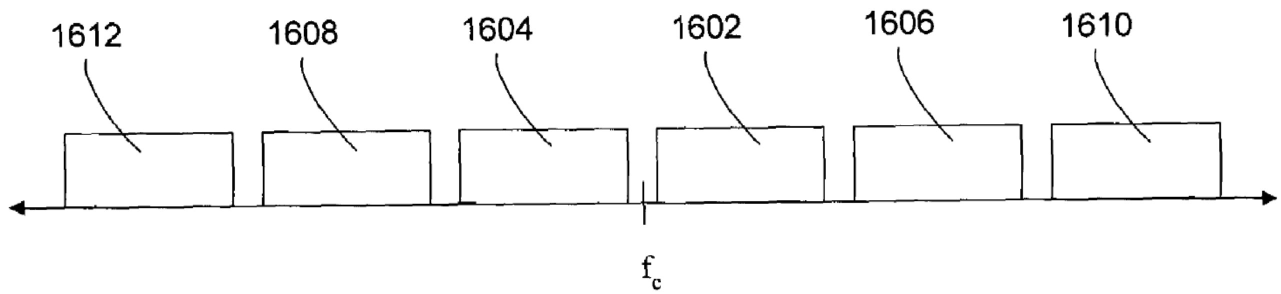
Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See, e.g.*, Shearer at Figure 10.

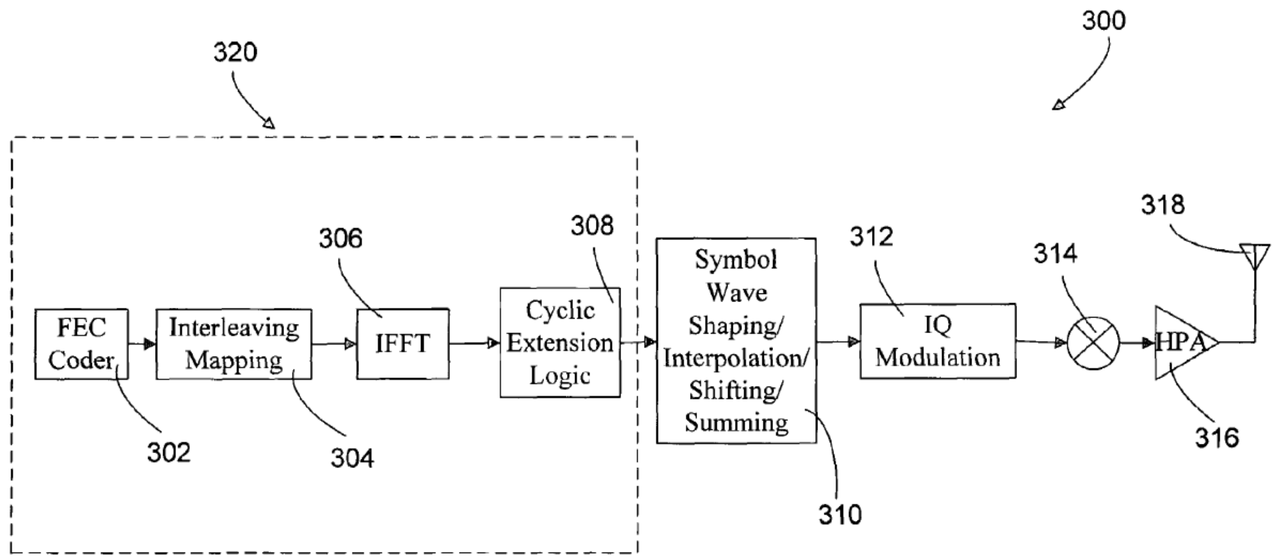
Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 *See, e.g.*, Shearer at Figure 11.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See*, *e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.8] combining the first up-converted analog signal and the second up-converted analog signal to produce a combined up-converted signal;	Shearer discloses "combining the first up-converted analog signal and the second up-converted analog signal to produce a combined up-converted signal." See, e.g.:

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See*, *e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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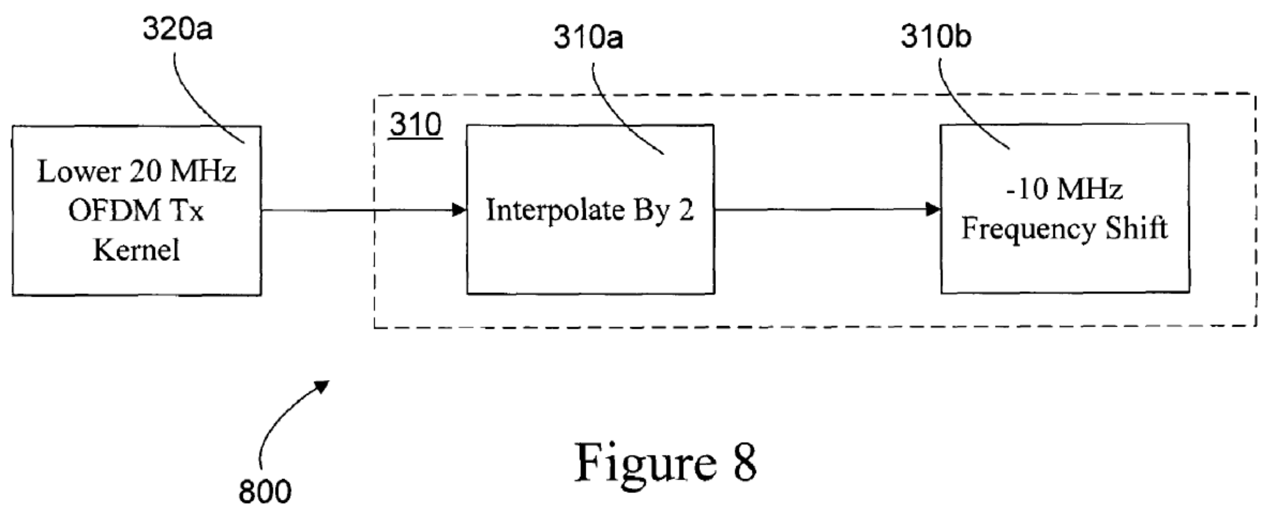
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  *See, e.g.*, Shearer at Figure 8.

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	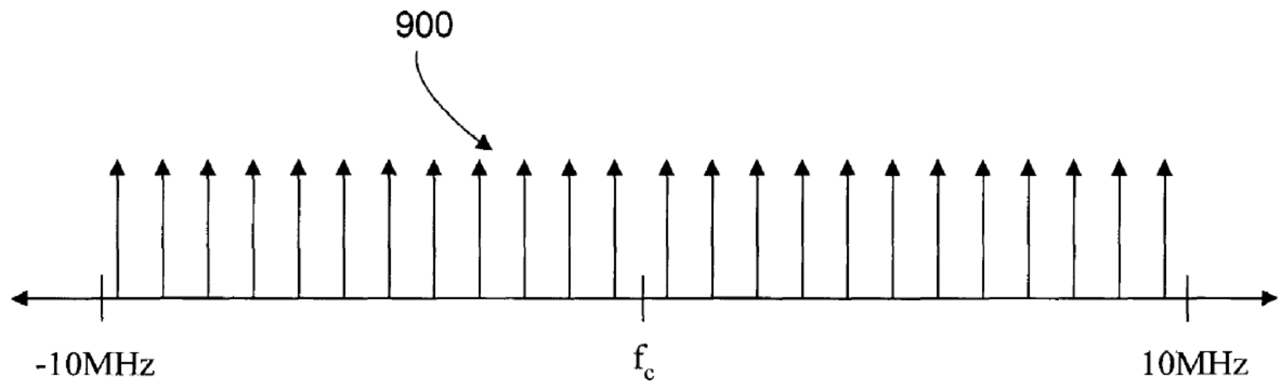 Figure 9 *See*, *e.g.*, Shearer at Figure 9.

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	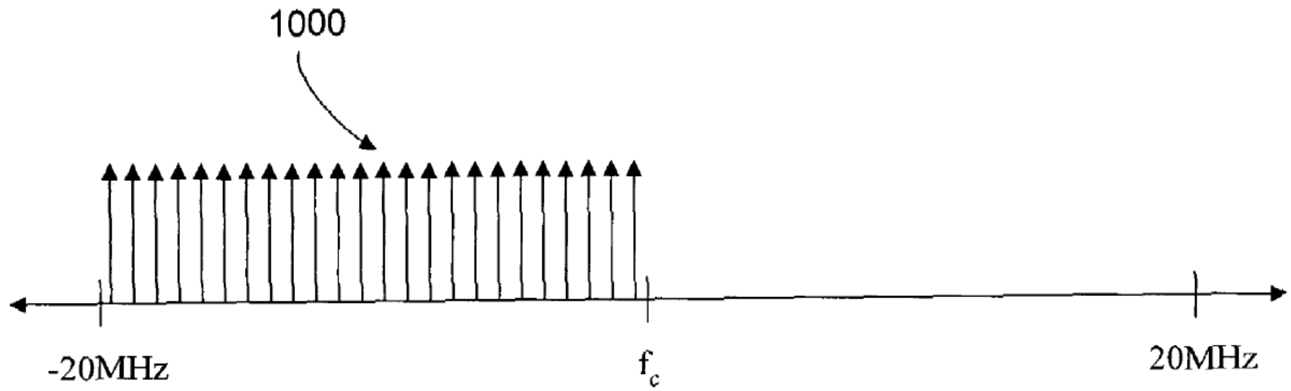 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

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	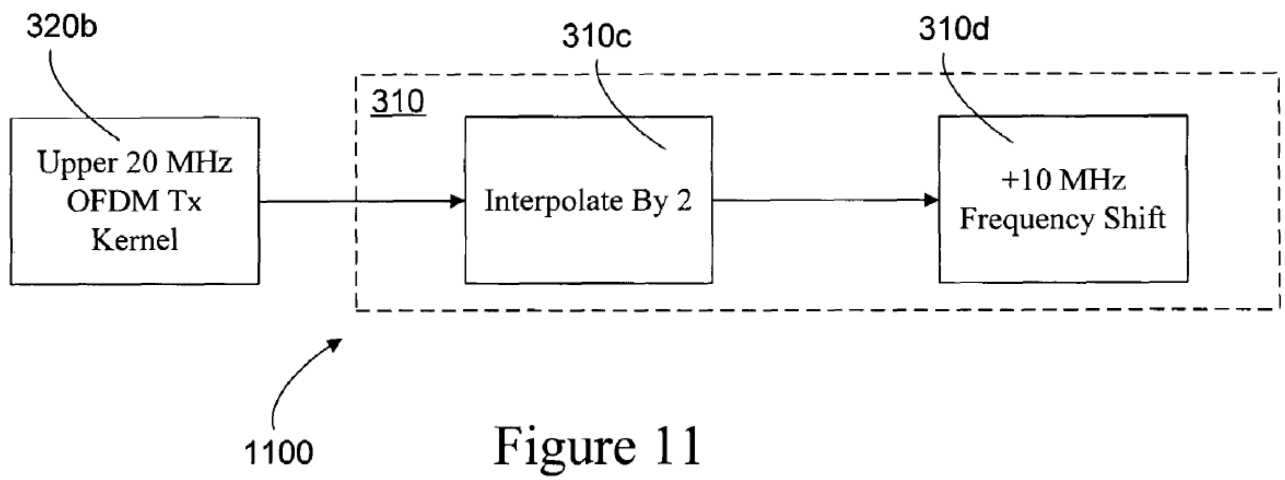 Figure 11 *See, e.g.*, Shearer at Figure 11.

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	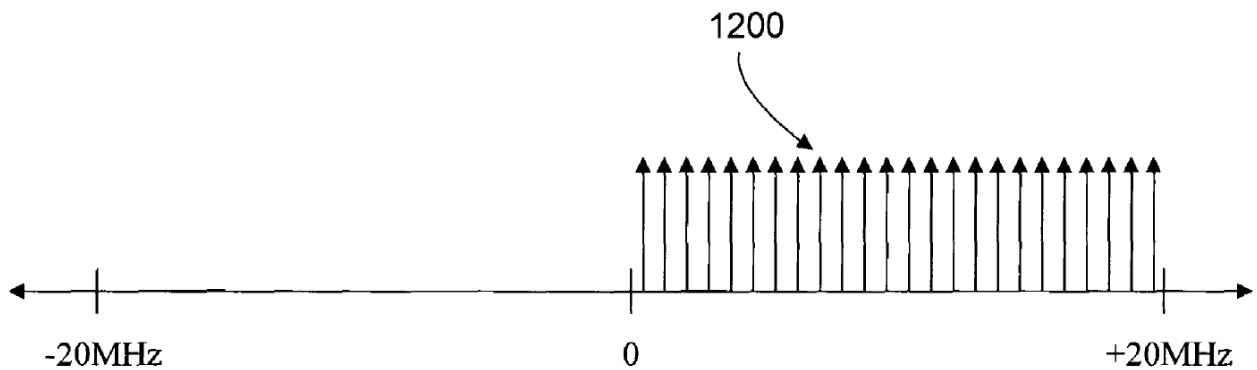 Figure 12 *See, e.g.*, Shearer at Figure 12.

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	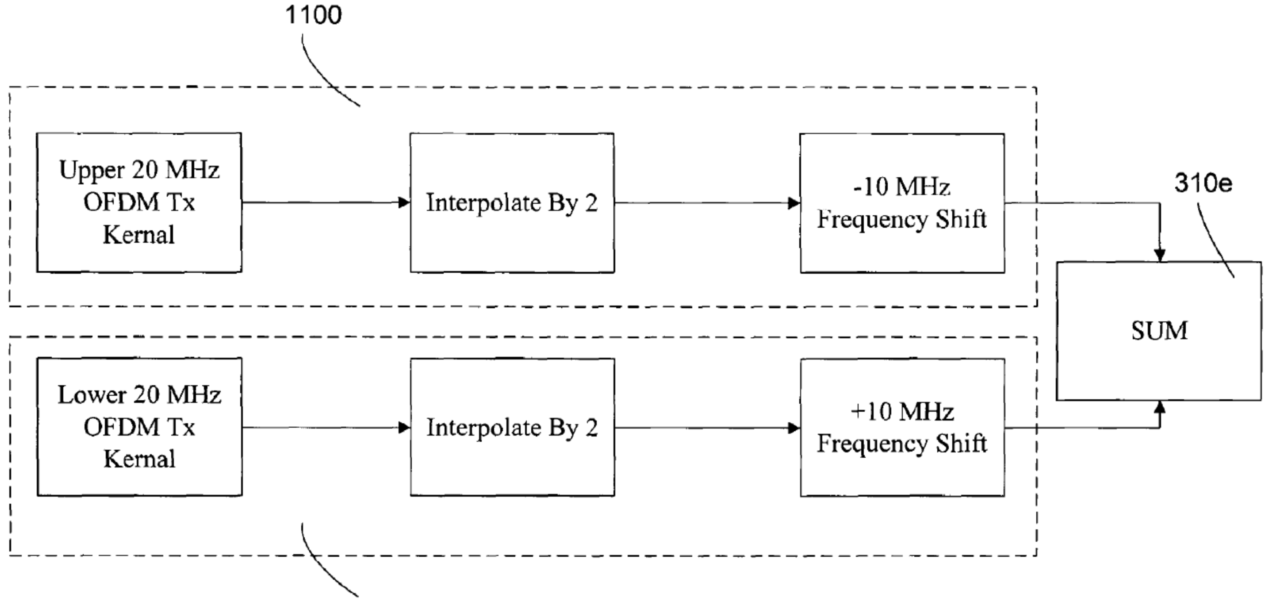 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

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	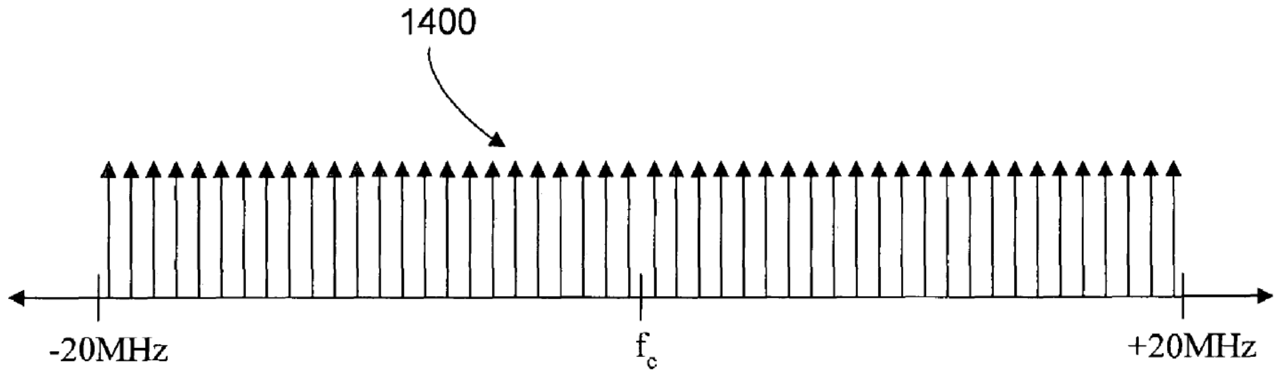 Figure 14 *See, e.g.*, Shearer at Figure 14.

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	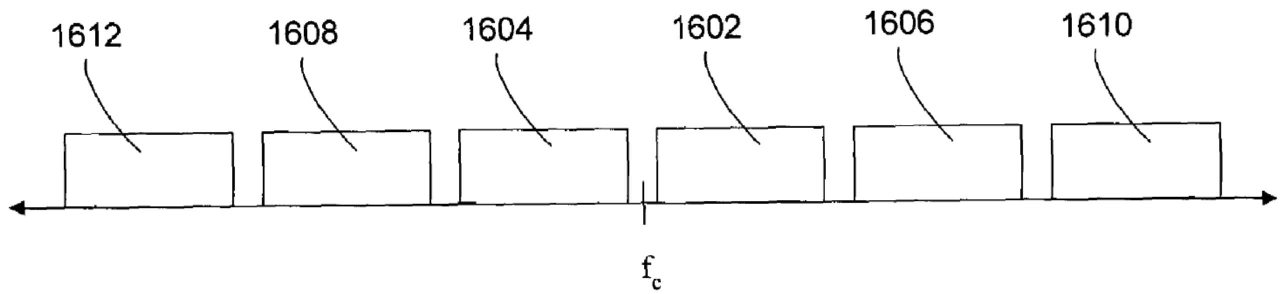 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.9] amplifying the combined up-converted signal in a power amplifier resulting in an amplified combined up-converted signal; and	Shearer discloses “amplifying the combined up-converted signal in a power amplifier resulting in an amplified combined up-converted signal.” See, e.g.:

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	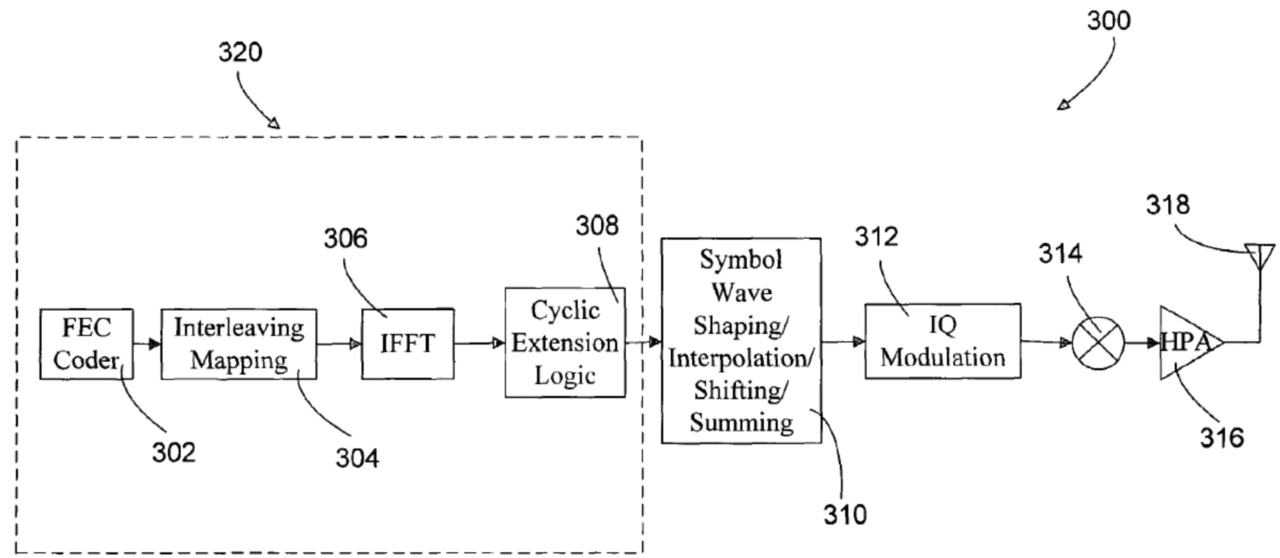 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 ("802.11") is set out in "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications" and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate "dead spots," and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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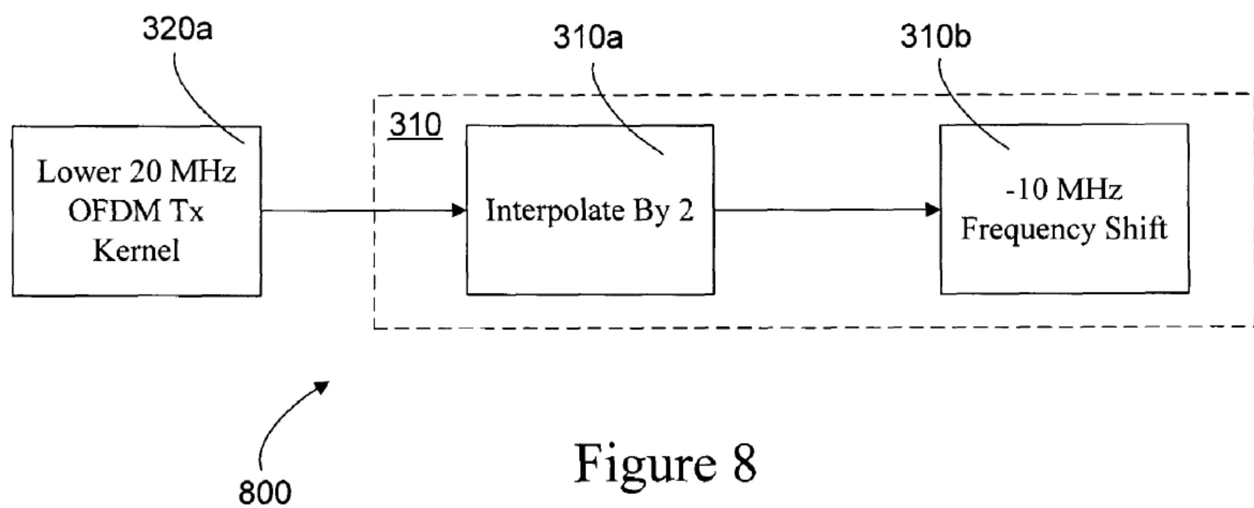
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

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	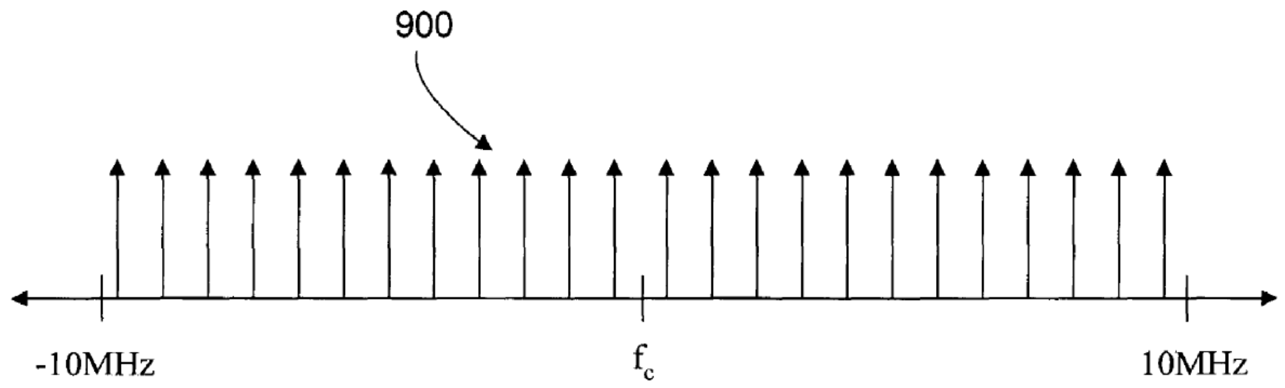 Figure 9 *See, e.g.*, Shearer at Figure 9.

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	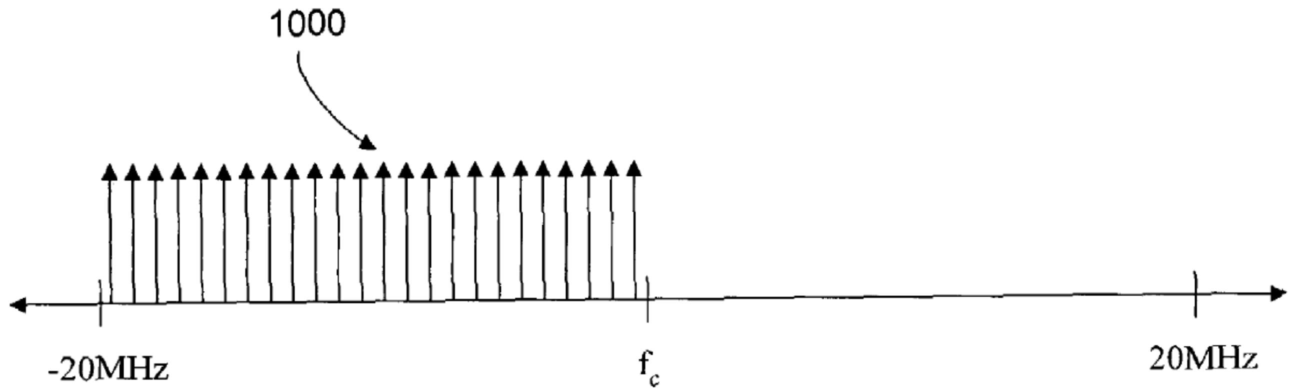 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

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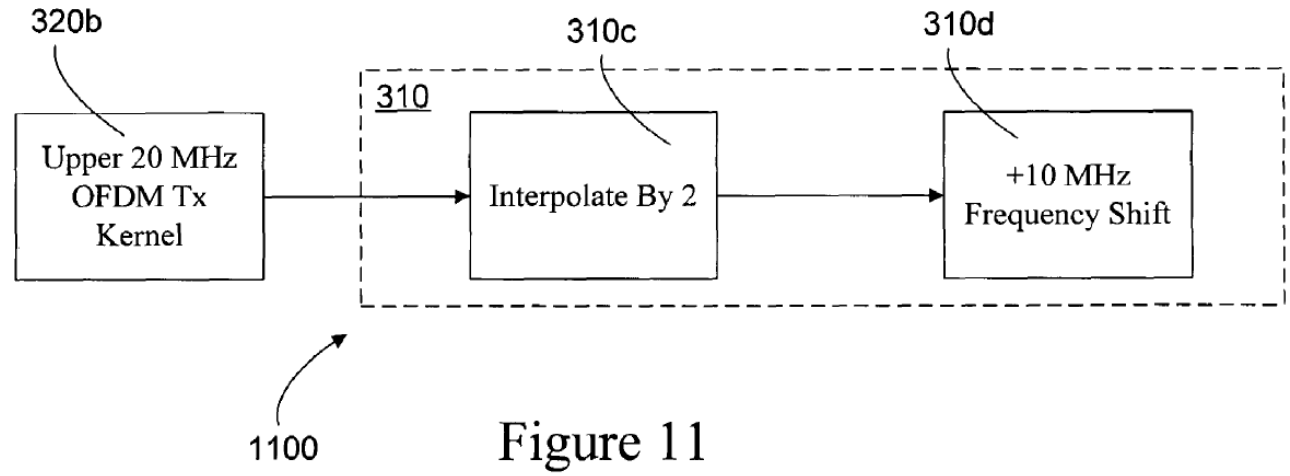
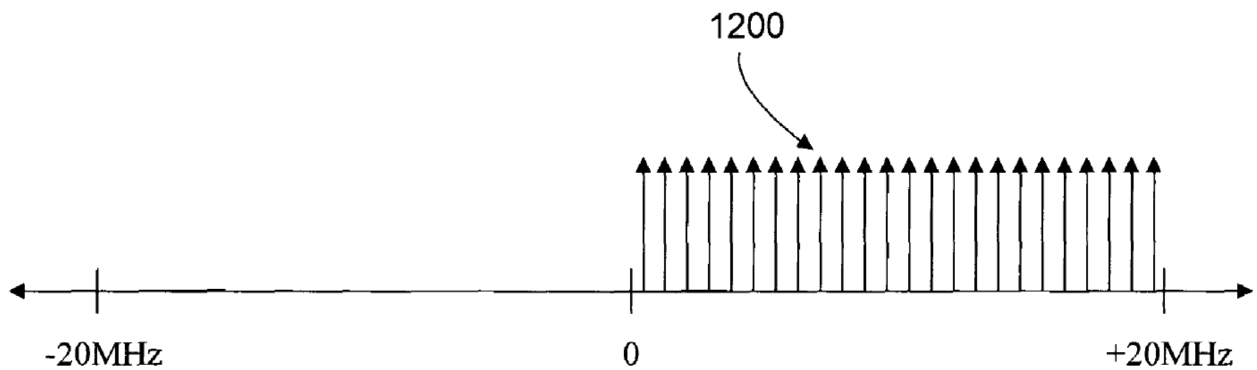
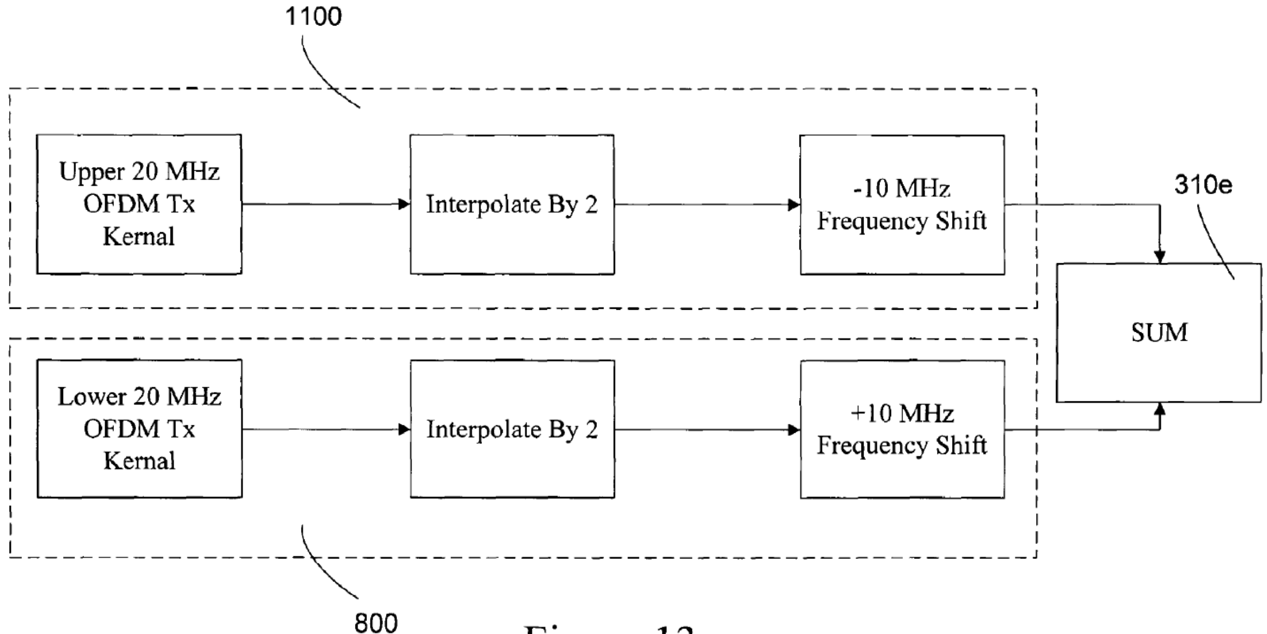
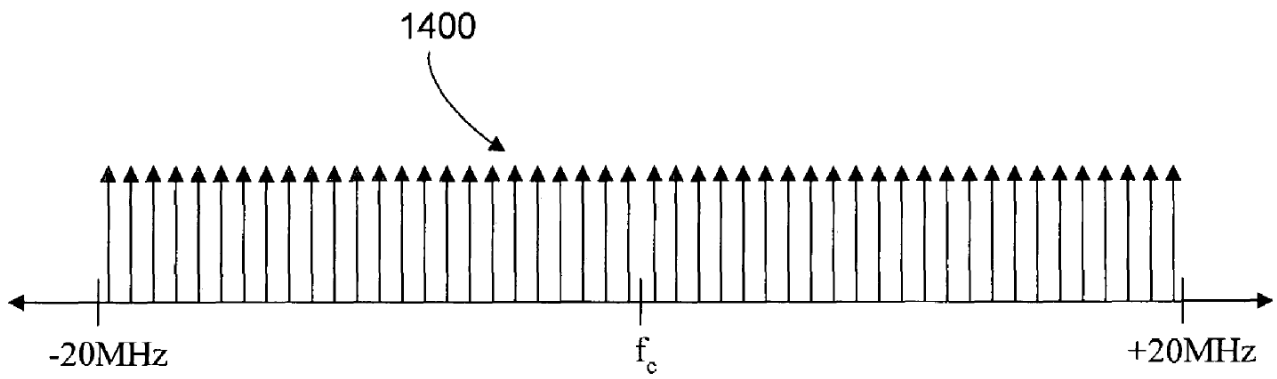
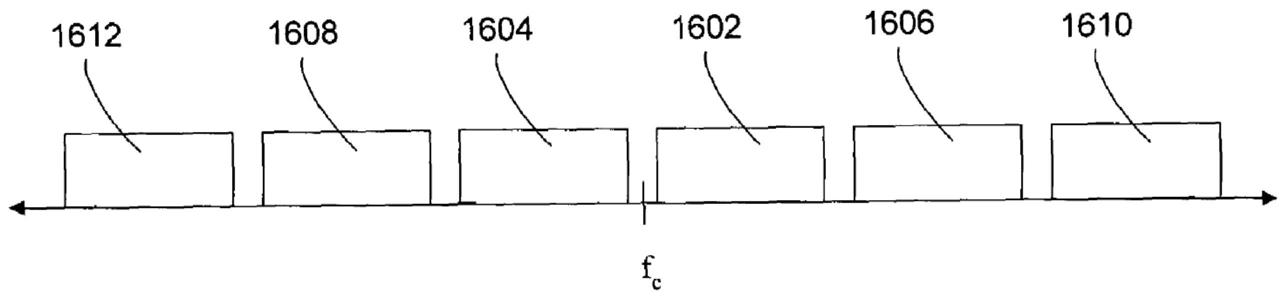
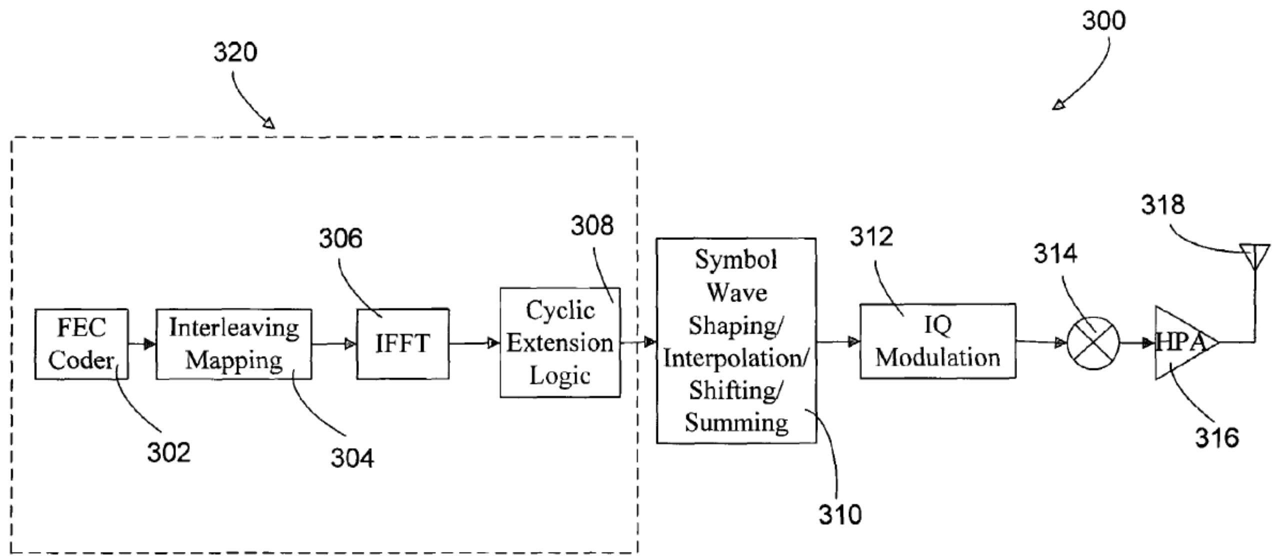
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See*, *e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.10] transmitting the amplified combined up-converted signal on a first antenna,	Shearer discloses "transmitting the amplified combined up-converted signal on a first antenna." See, e.g.:

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 ("802.11") is set out in "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications" and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate "dead spots," and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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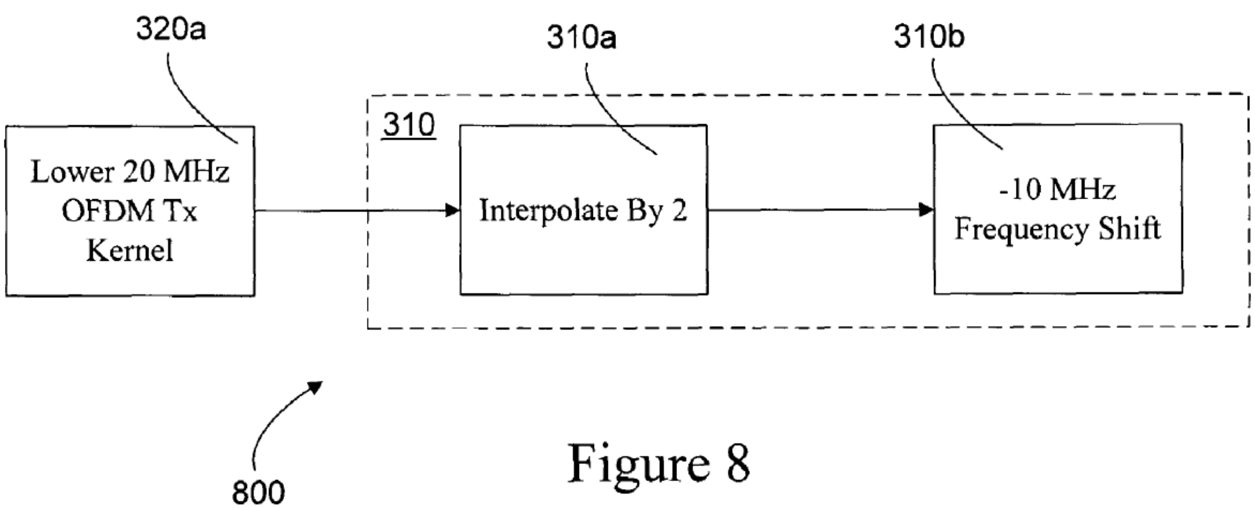
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See*, *e.g.*, Shearer at 9:25-54.  Figure 8 *See*, *e.g.*, Shearer at Figure 8.

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	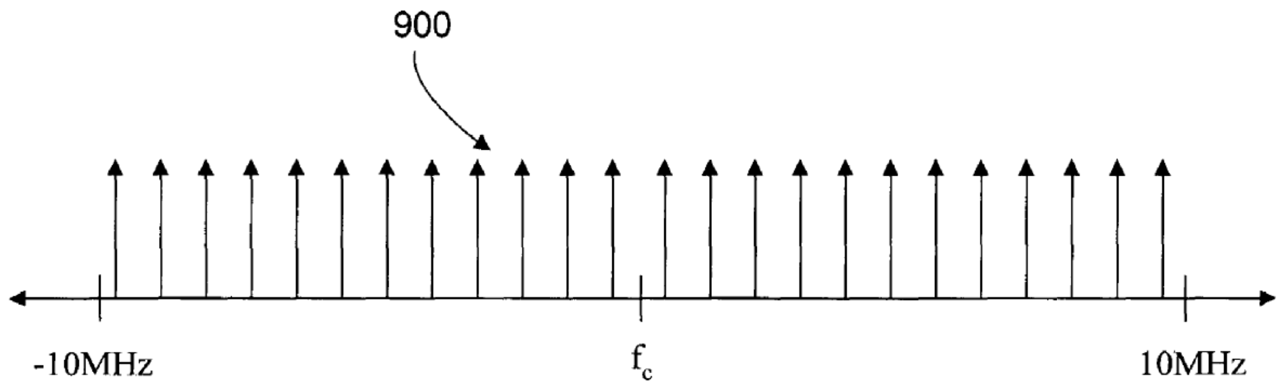 Figure 9 *See, e.g.*, Shearer at Figure 9.

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	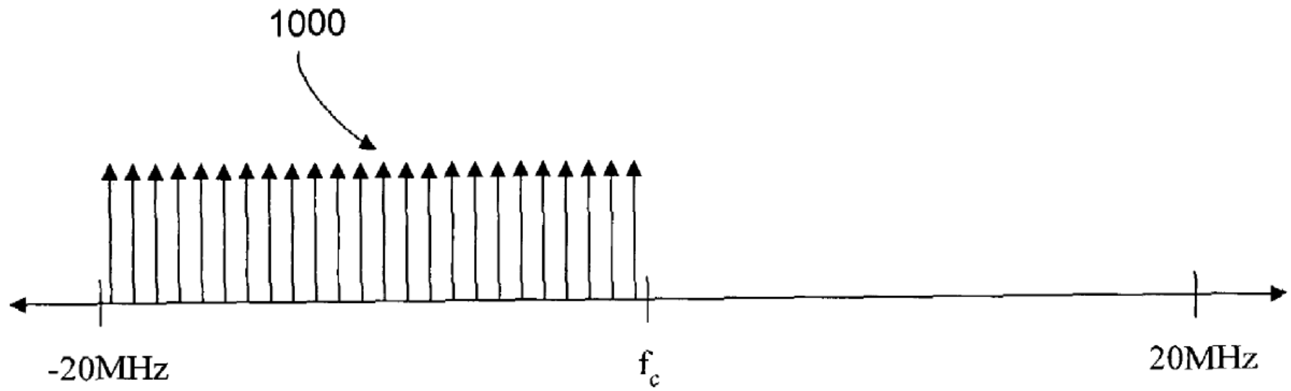 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

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	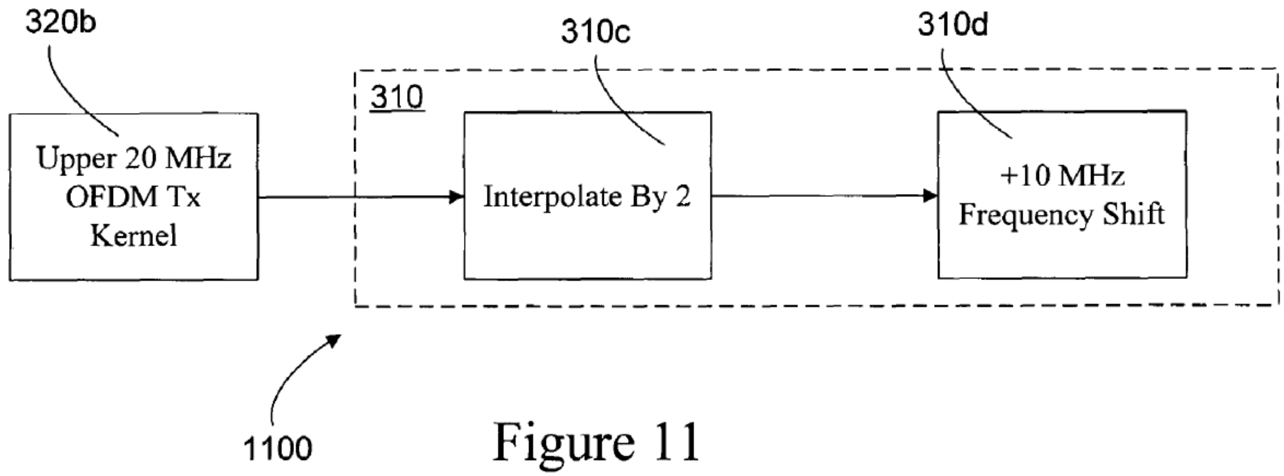 Figure 11 *See, e.g.*, Shearer at Figure 11.

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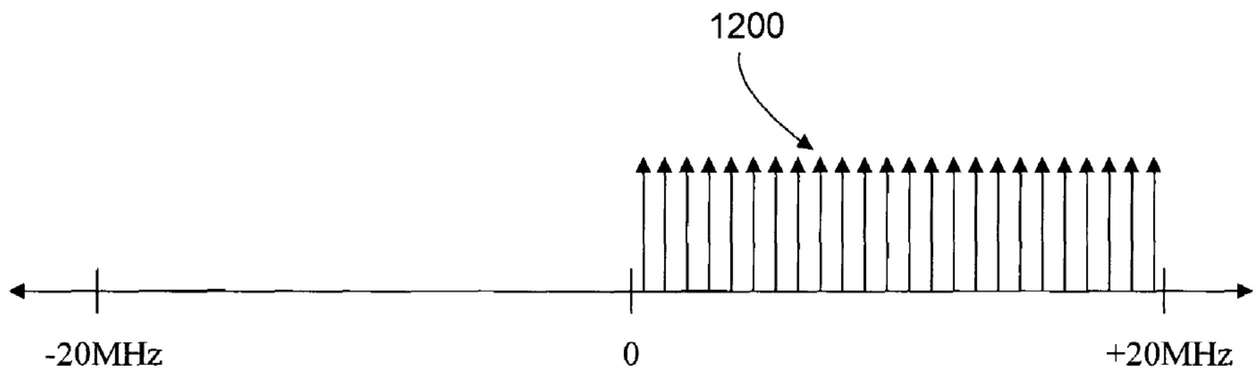
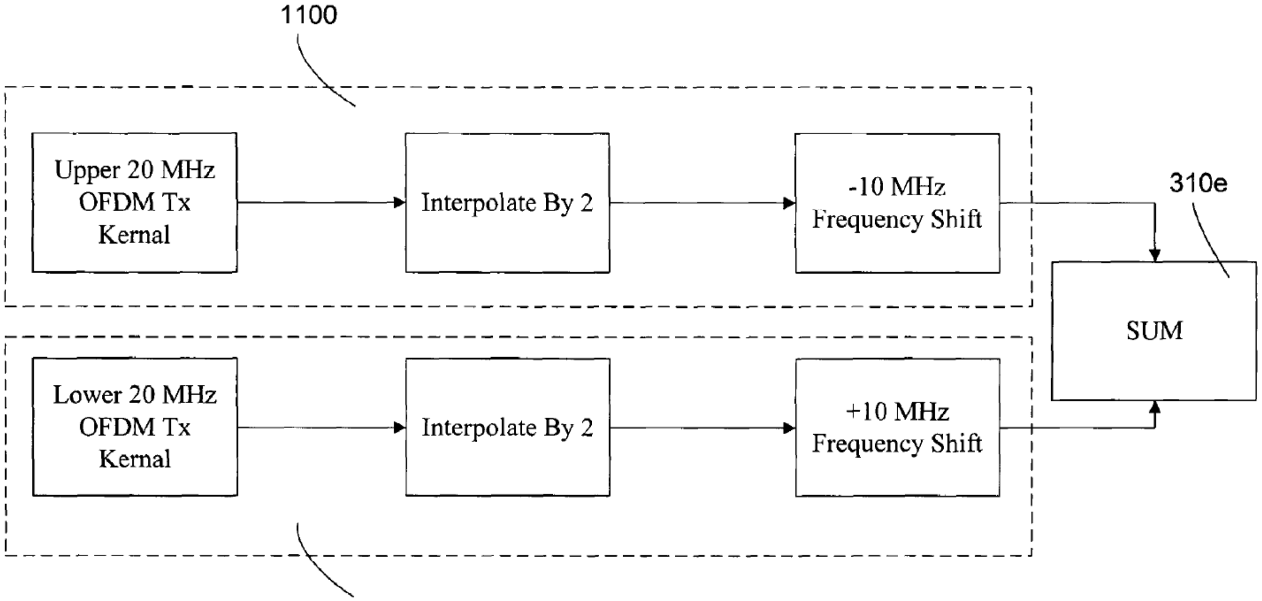
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

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	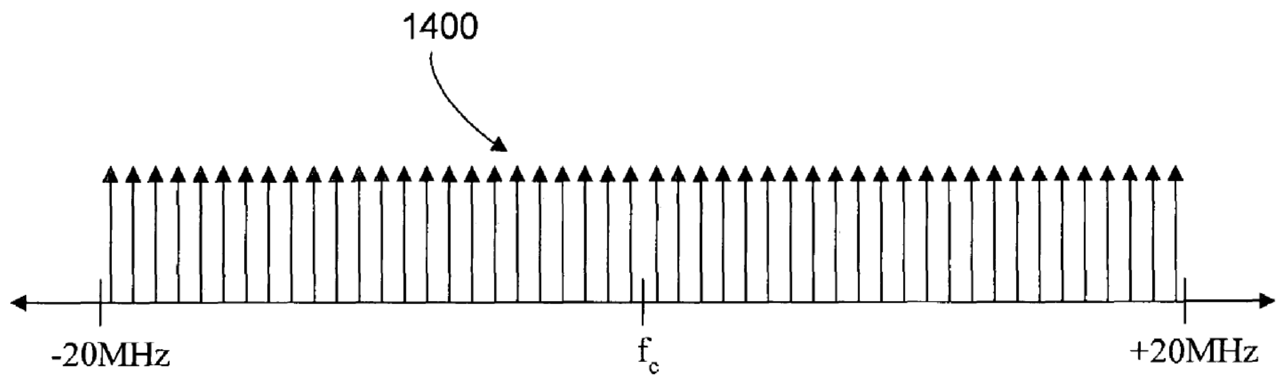 Figure 14 *See, e.g.*, Shearer at Figure 14.

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	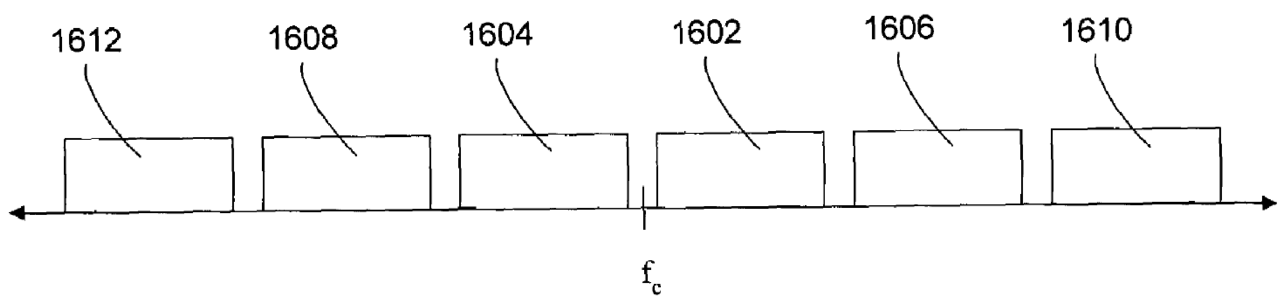 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.11] wherein the bandwidth of said power amplifier is greater than the difference between a lowest frequency in the first up-converted frequency range and a highest frequency in the	Shearer discloses "wherein the bandwidth of said power amplifier is greater than the difference between a lowest frequency in the first up-converted frequency range and a highest frequency in the second up-converted frequency range." See, e.g.:

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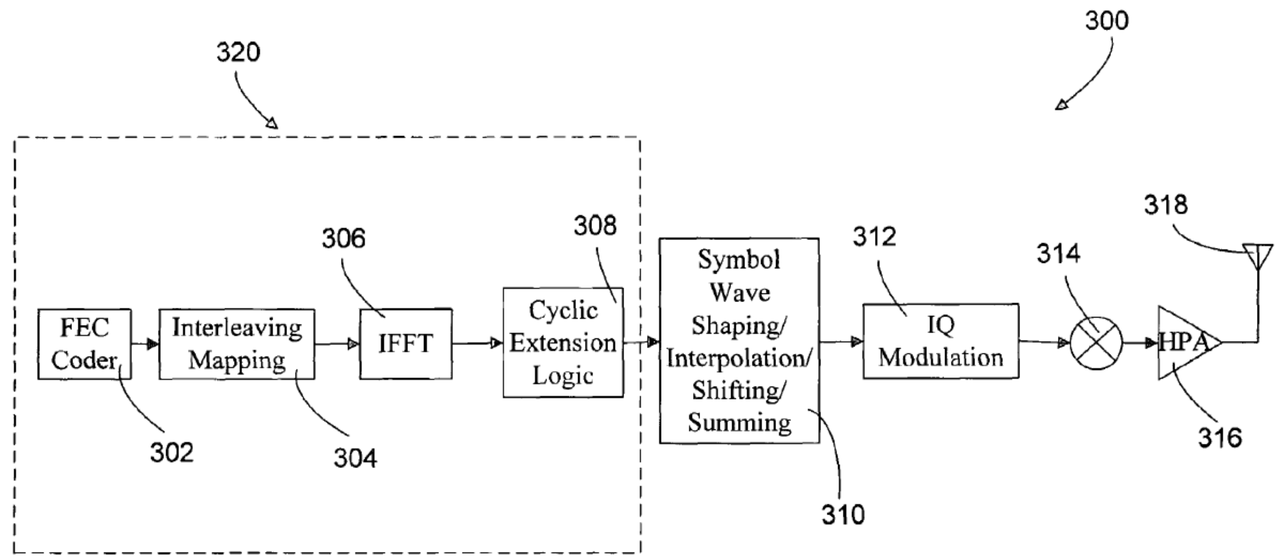
second up-converted frequency range.	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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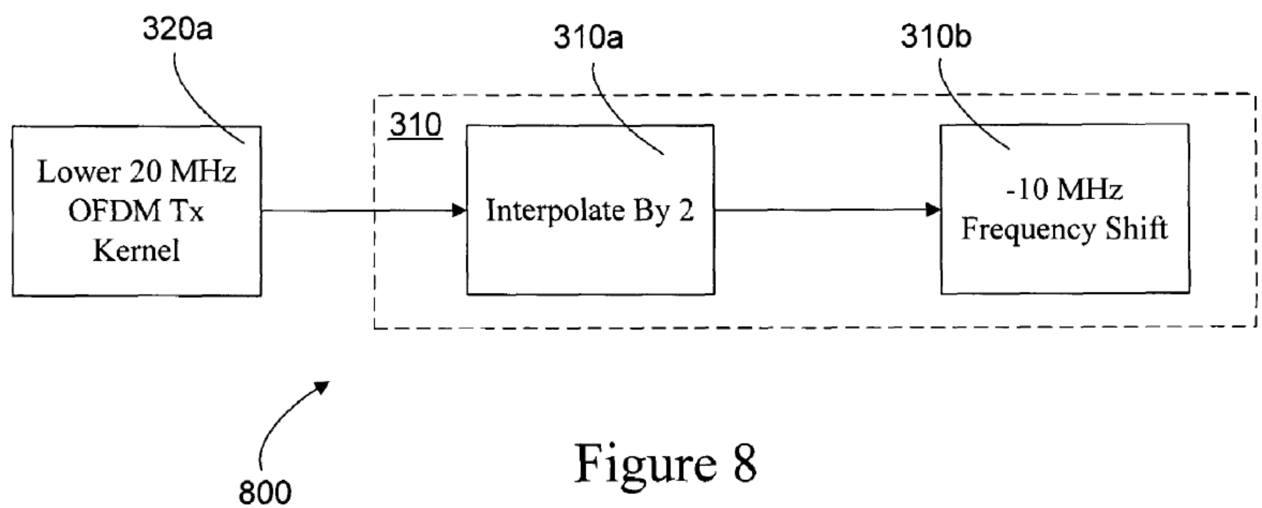
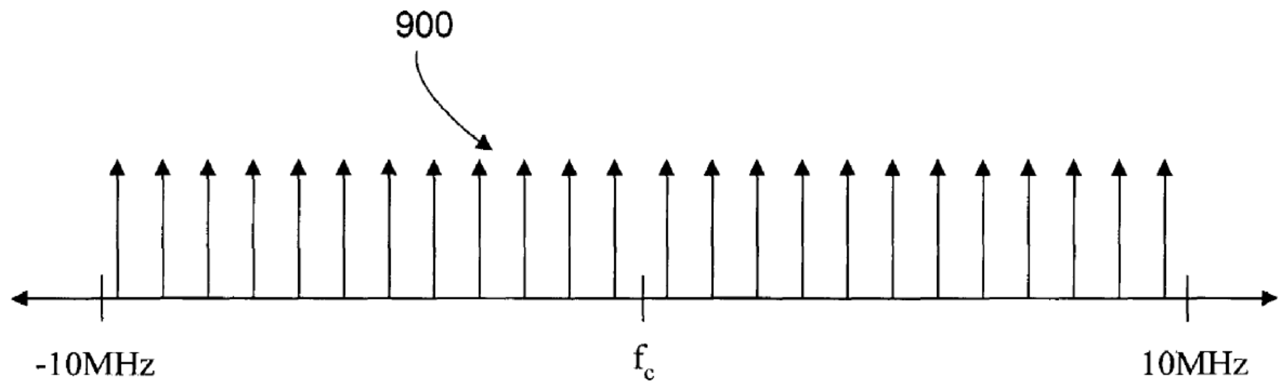
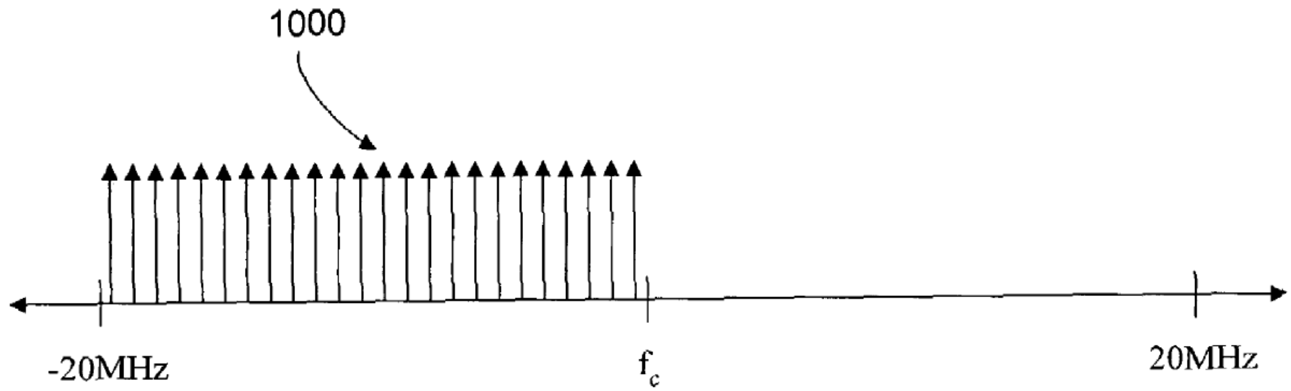
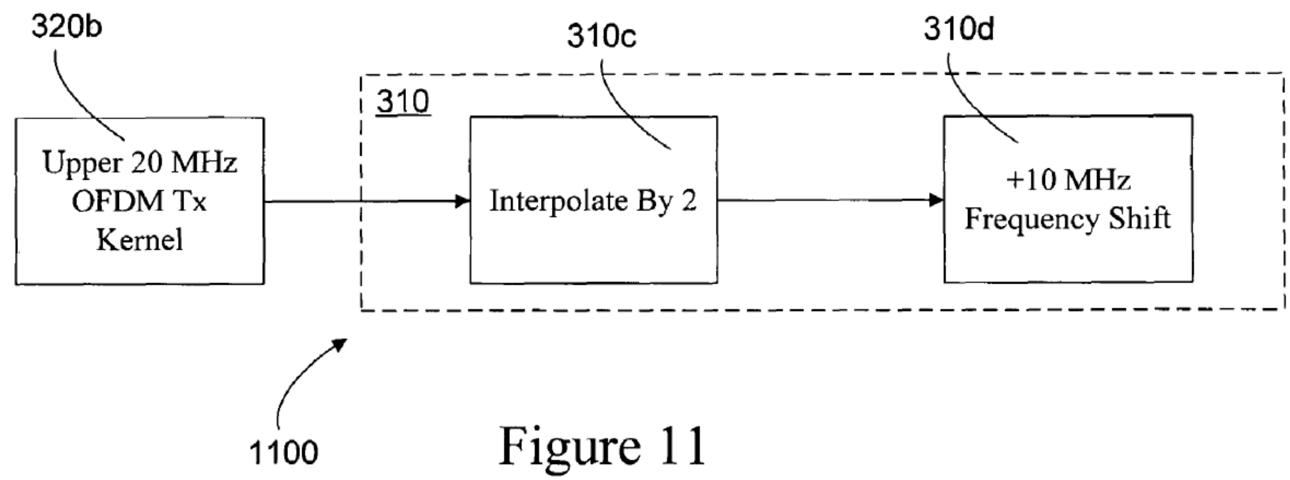
	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

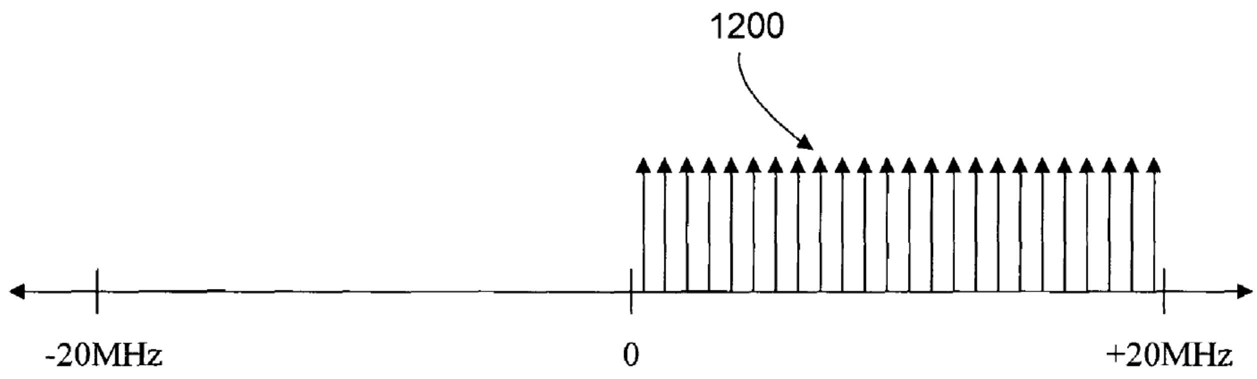
Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

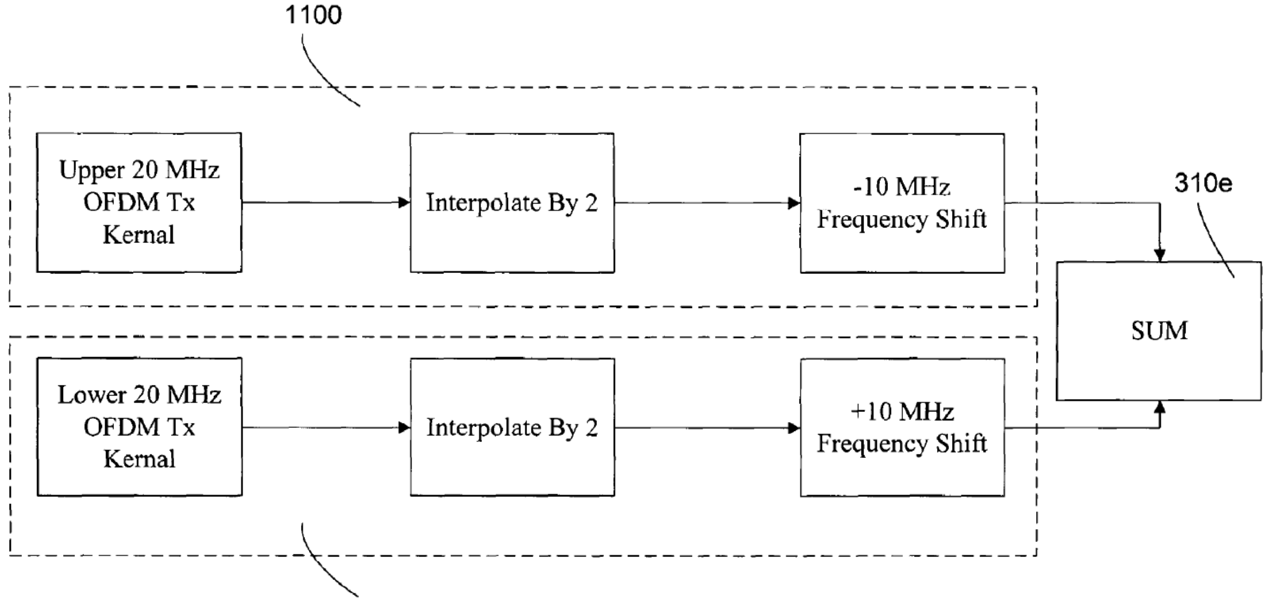
Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See*, *e.g.*, Shearer at 9:25-54.  Figure 8 *See*, *e.g.*, Shearer at Figure 8.

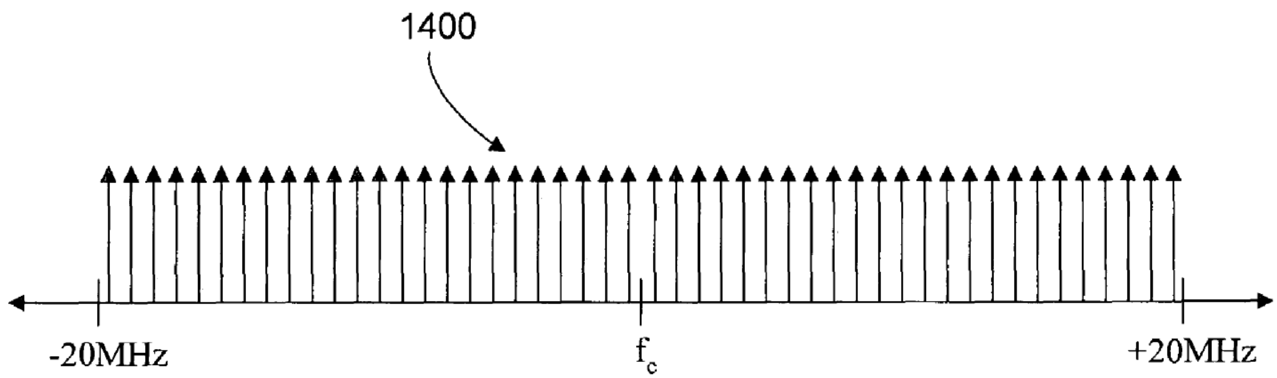
Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See*, *e.g.*, Shearer at Figure 9.

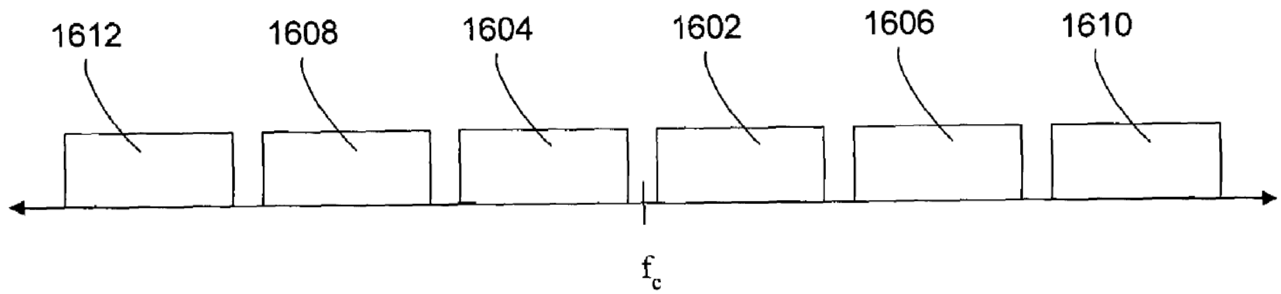
Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

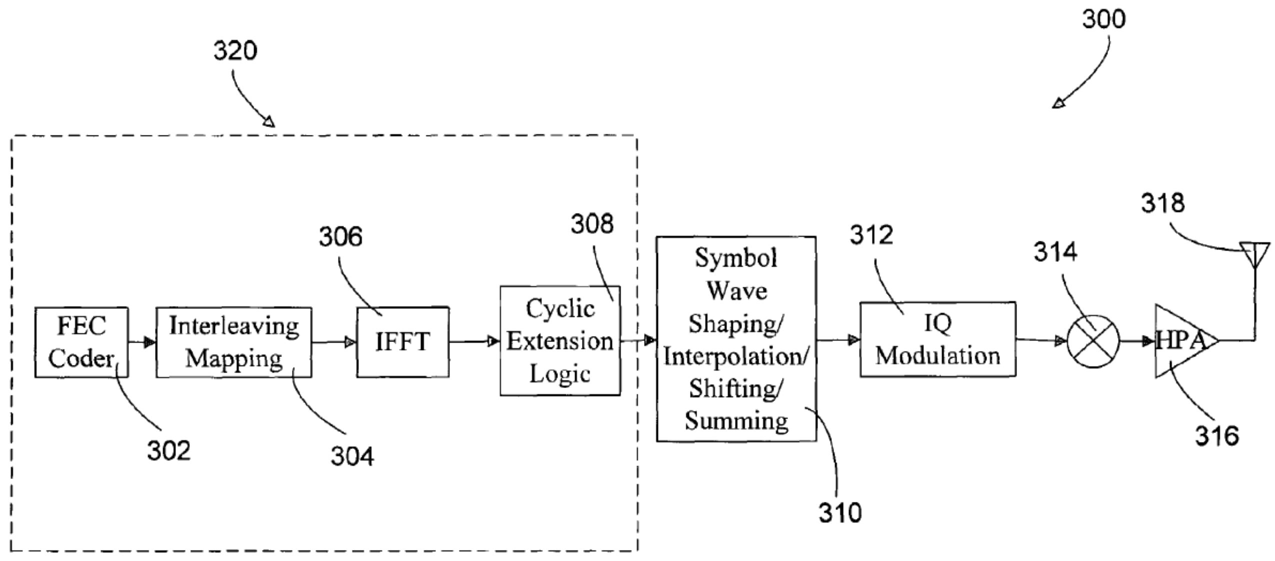
Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 10 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 10 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See*, *e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 13 of the '802 Patent	Prior Art Reference – Shearer
[13.1] The method of claim 10	Shearer discloses all the elements of claim 10 for all the reasons provided above.
[13.2] wherein the first digital signal is encoded using a first wireless protocol and the	Shearer discloses "wherein the first digital signal is encoded using a first wireless protocol and the second digital signal is encoded using a second wireless protocol." See, e.g.:

Claim 13 of the '802 Patent	Prior Art Reference – Shearer
second digital signal is encoded using a second wireless protocol.	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of

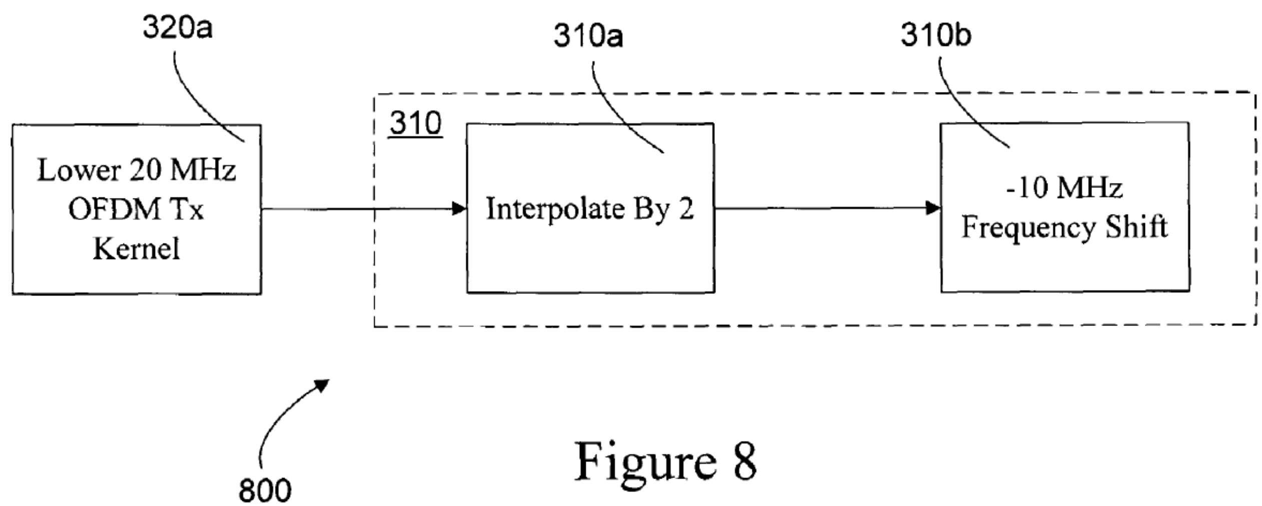
Claim 13 of the '802 Patent	Prior Art Reference – Shearer
	the terminals are capable of communicating with at least two of the access points when located within a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 ("802.11") is set out in "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications" and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate "dead spots," and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308.

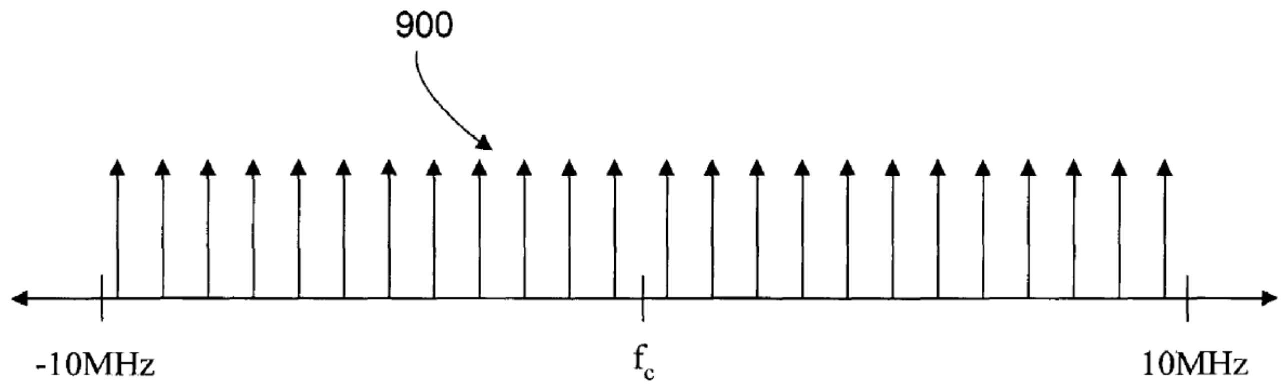
Claim 13 of the '802 Patent	Prior Art Reference – Shearer
	During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC) code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz

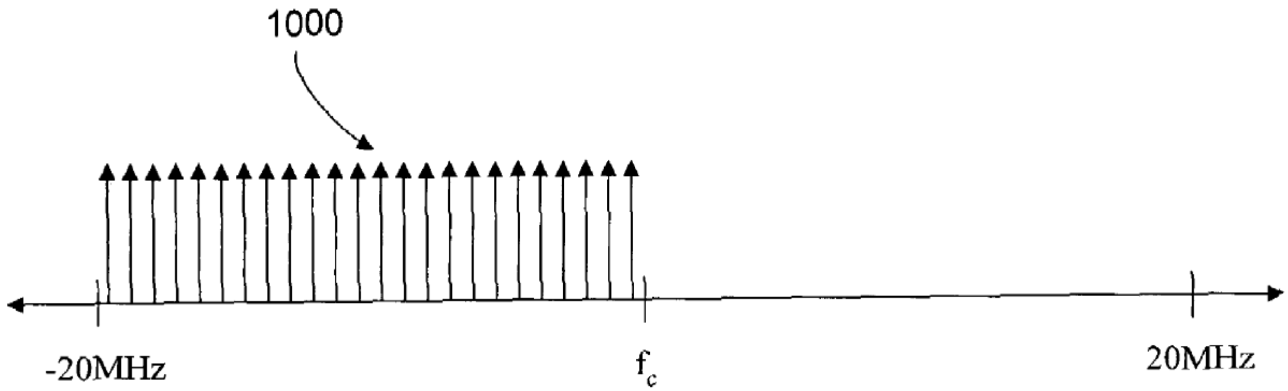
Claim 13 of the '802 Patent	Prior Art Reference – Shearer
	channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A

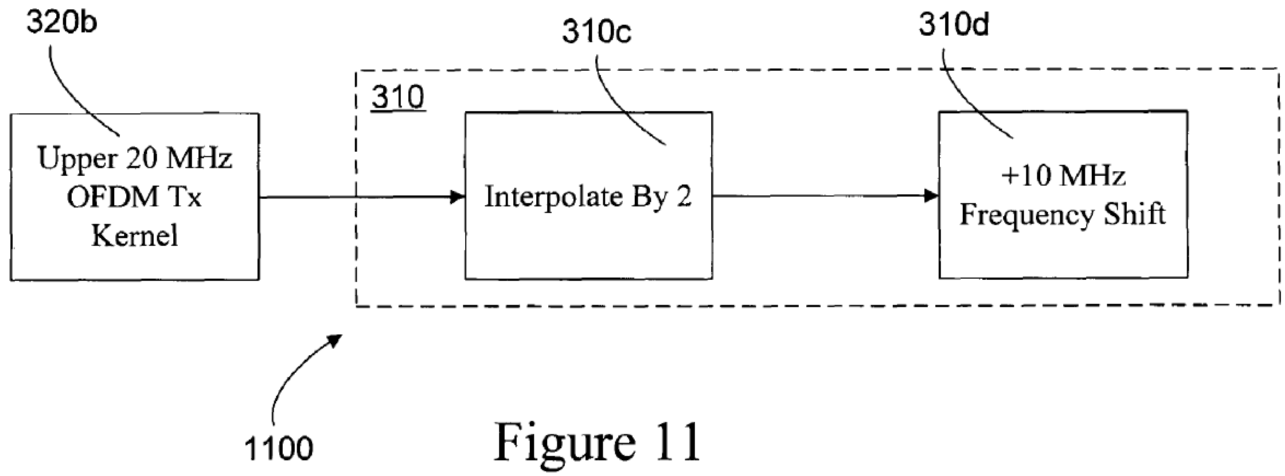
Claim 13 of the '802 Patent	Prior Art Reference – Shearer
	lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are

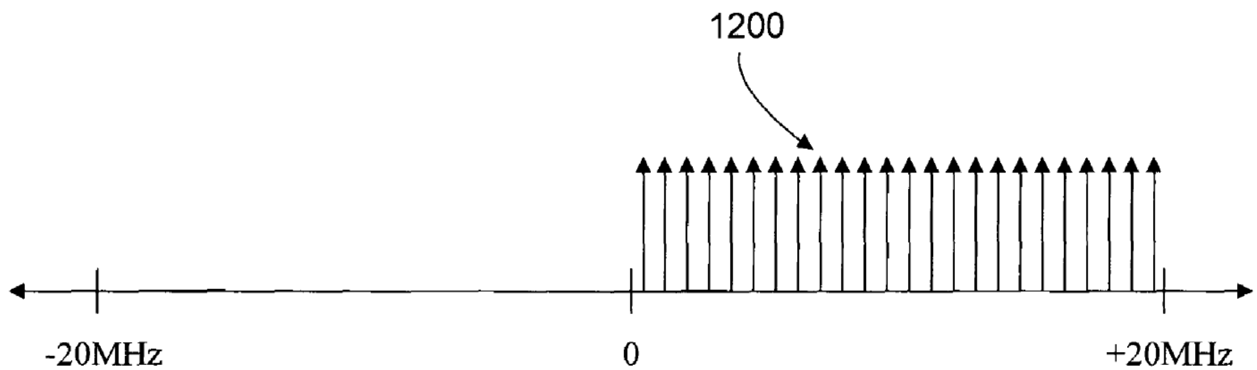
Claim 13 of the '802 Patent	Prior Art Reference – Shearer
	received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for

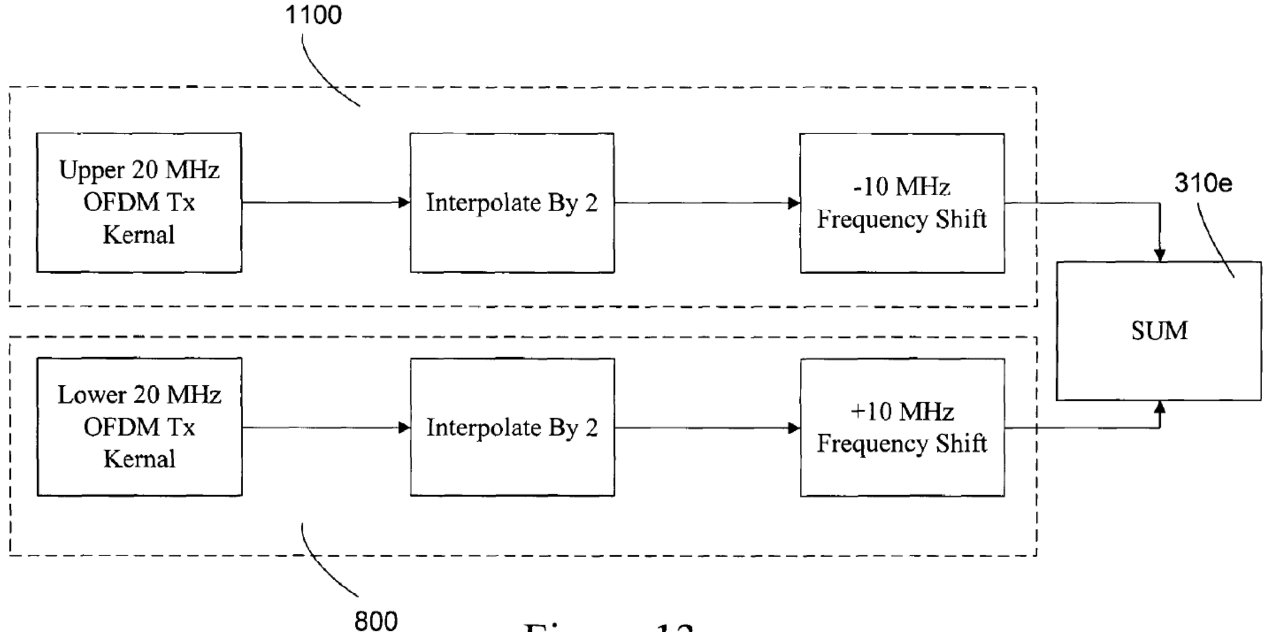
Claim 13 of the '802 Patent	Prior Art Reference – Shearer
	transmission. This process is applicable for any even number of input signals. Each simultaneous input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

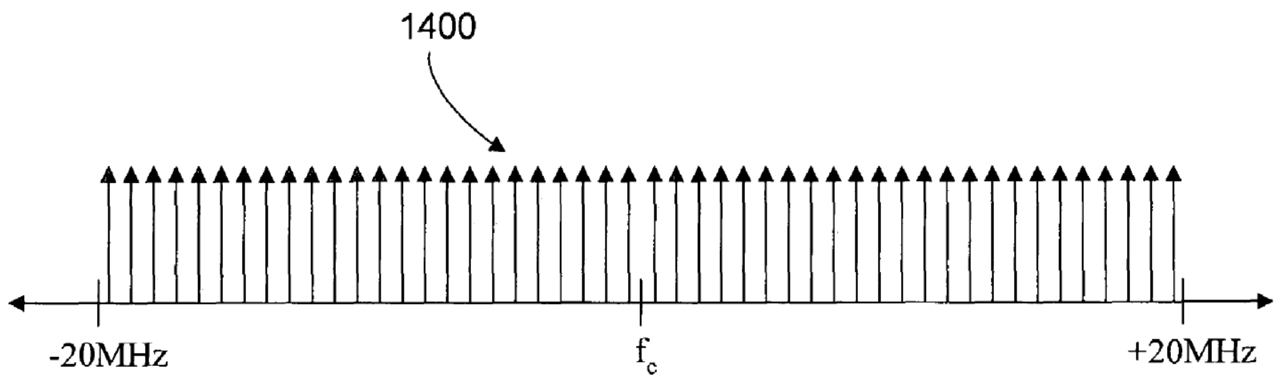
Claim 13 of the ’802 Patent	**Prior Art Reference – Shearer**
	 Figure 9 *See*, *e.g.*, Shearer at Figure 9.

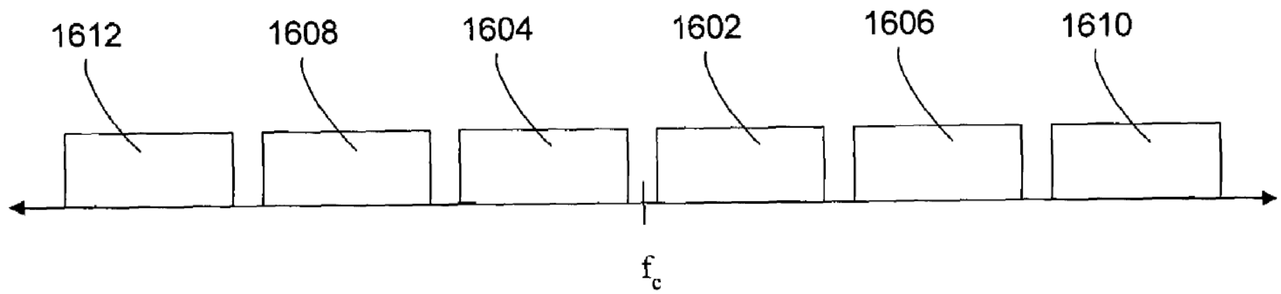
Claim 13 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

Claim 13 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

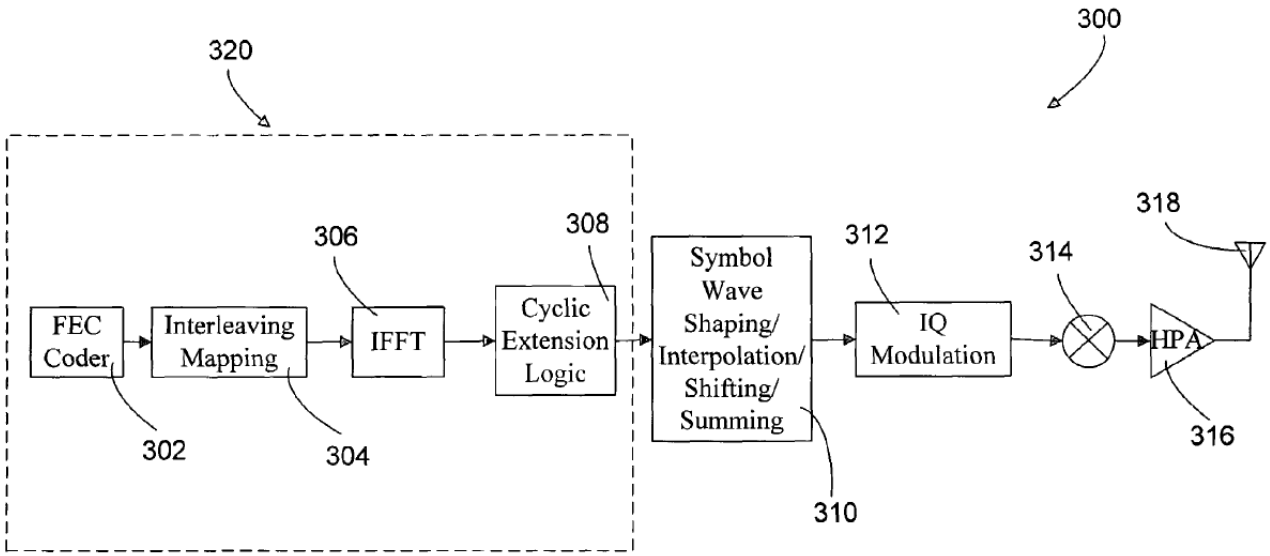
Claim 13 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 13 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 13 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 13 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
[14.1] The method of claim 10	Shearer discloses all the elements of claim 10 for all the reasons provided above.
[14.2] wherein the second data is the same as the first	Shearer discloses "wherein the second data is the same as the first data, the method further comprising." See, e.g.:

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
data, the method further comprising:	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	the terminals are capable of communicating with at least two of the access points when located within a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 ("802.11") is set out in "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications" and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to elimina te "dead spots," and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308.

Claim 14 of the ’802 Patent	Prior Art Reference – Shearer
	During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC) code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz

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	channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A

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	lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shif ter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are

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	received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for

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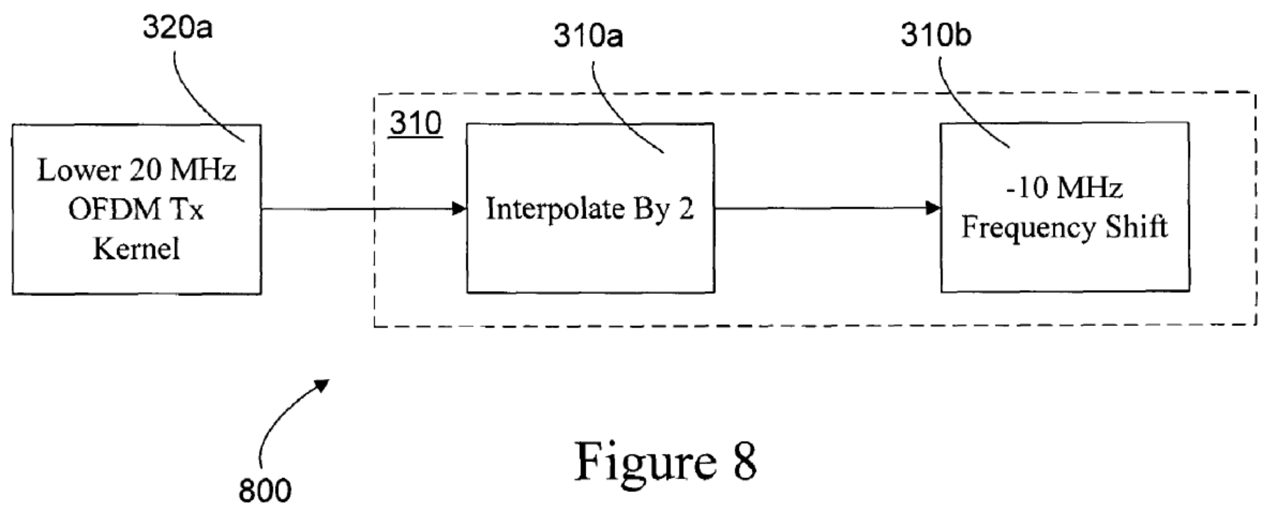
	transmission. This process is applicable for any even number of input signals. Each simultaneous input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

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	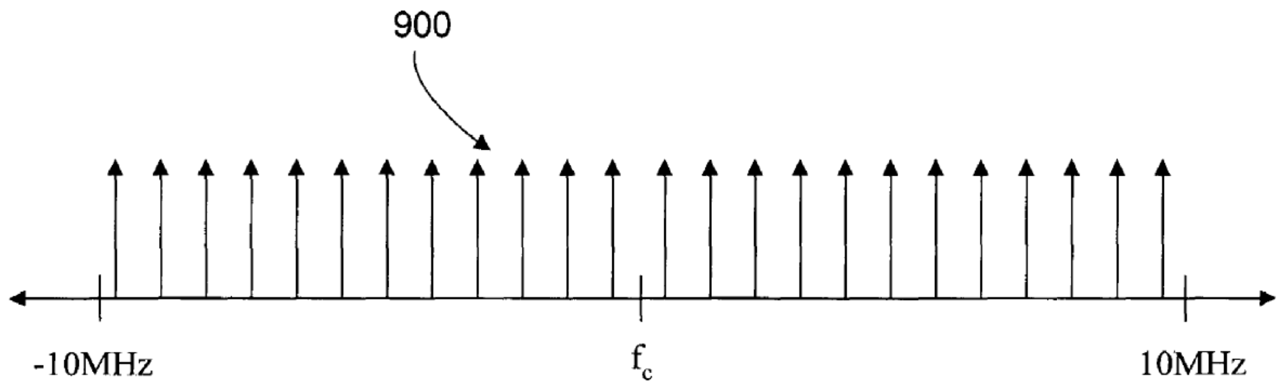 Figure 9 *See*, *e.g.*, Shearer at Figure 9.

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	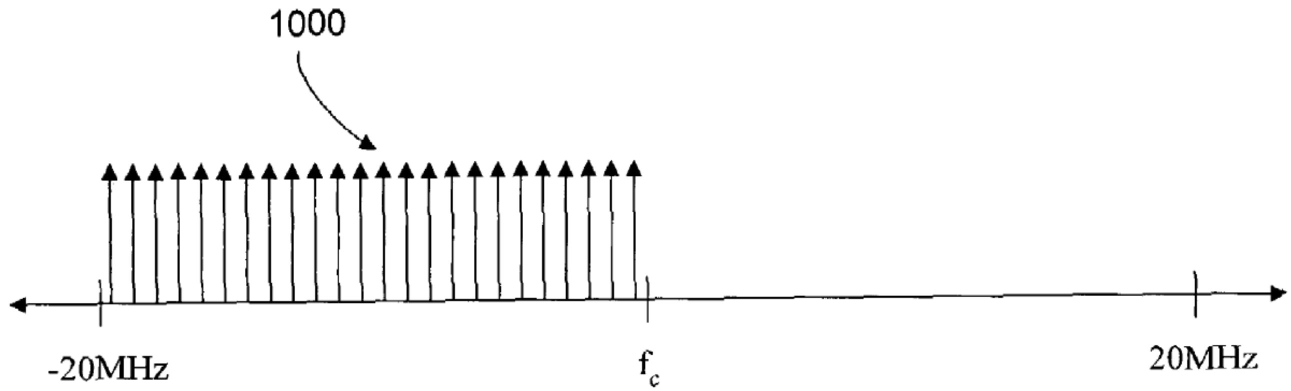 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

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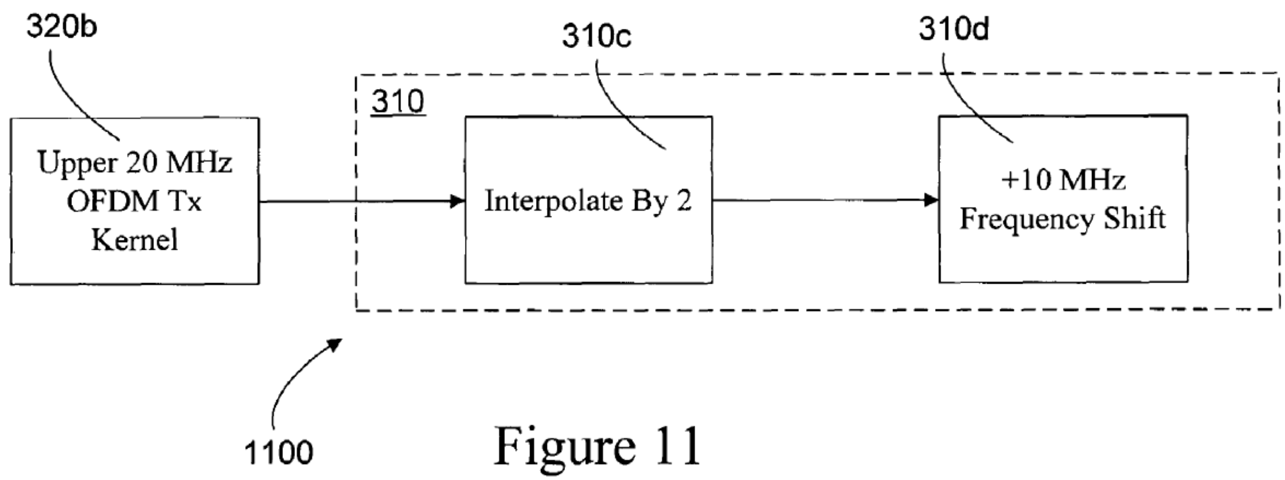
	 *See, e.g.*, Shearer at Figure 11.

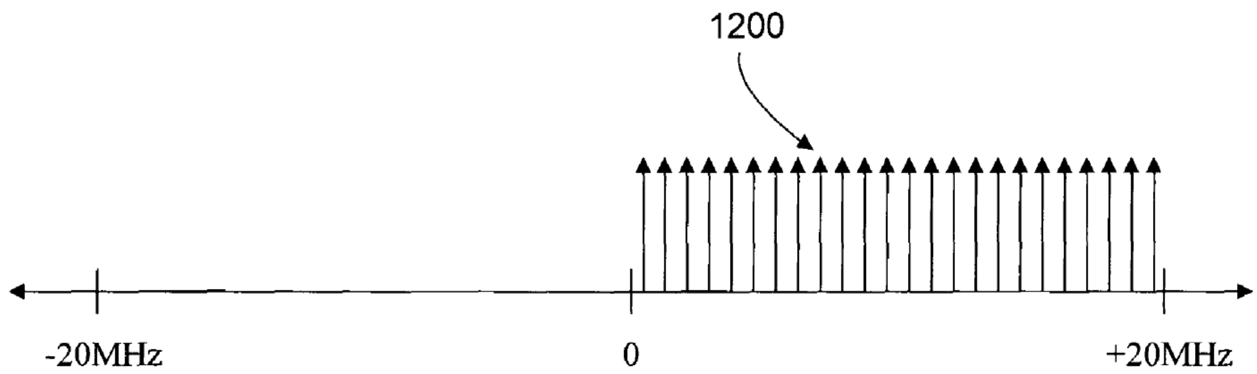
<table>
<tr><th>Claim 14 of the ’802 Patent</th><th>Prior Art Reference – Shearer</th></tr>
<tr><td></td><td>

Figure 12

See, e.g., Shearer at Figure 12.</td></tr>
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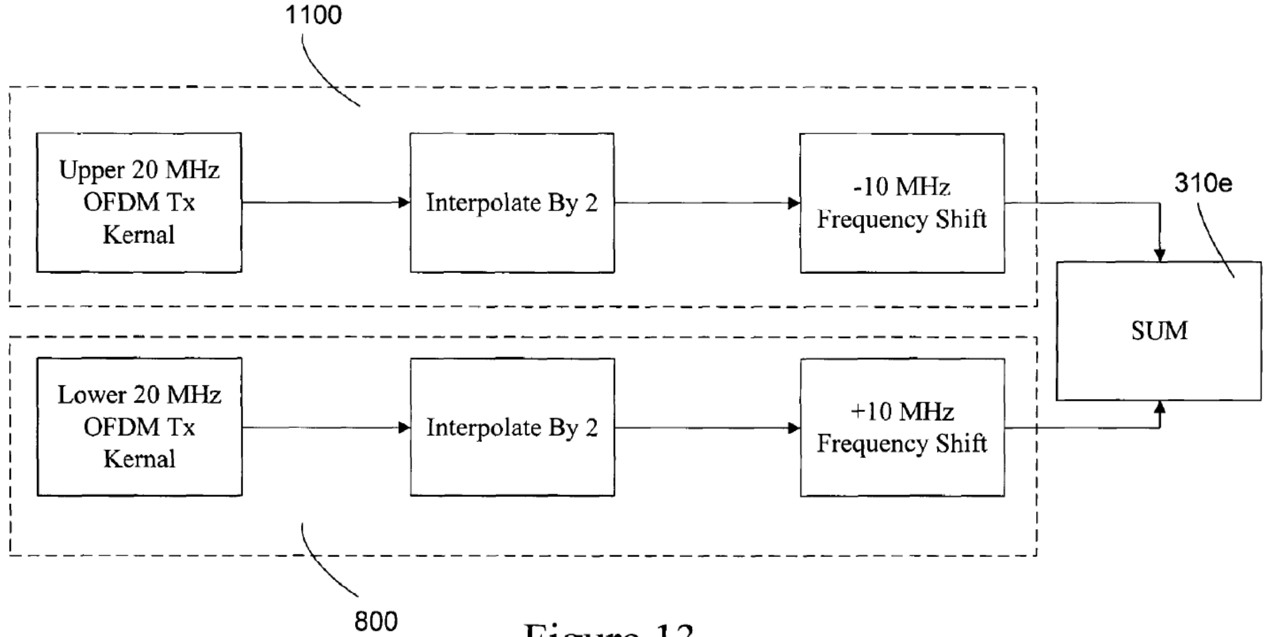
Claim 14 of the '802 Patent	**Prior Art Reference – Shearer**
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

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	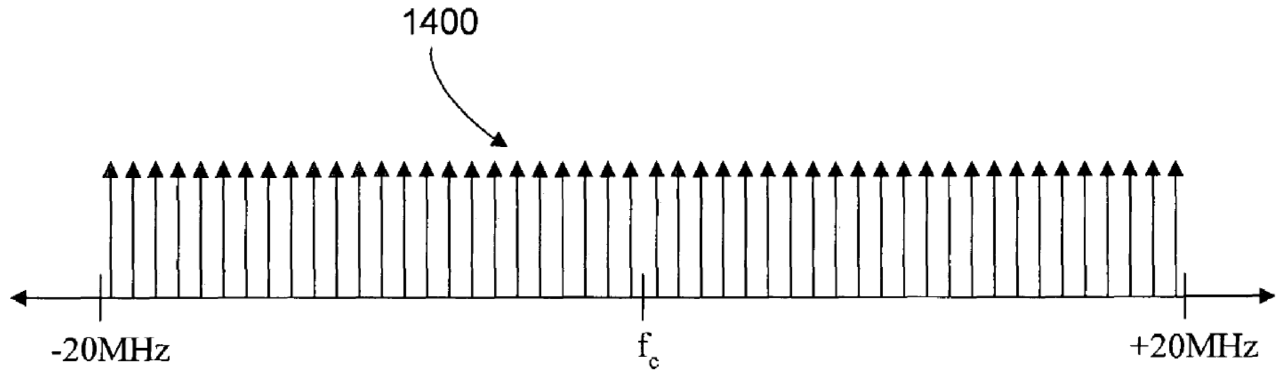 Figure 14 *See, e.g.*, Shearer at Figure 14.

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	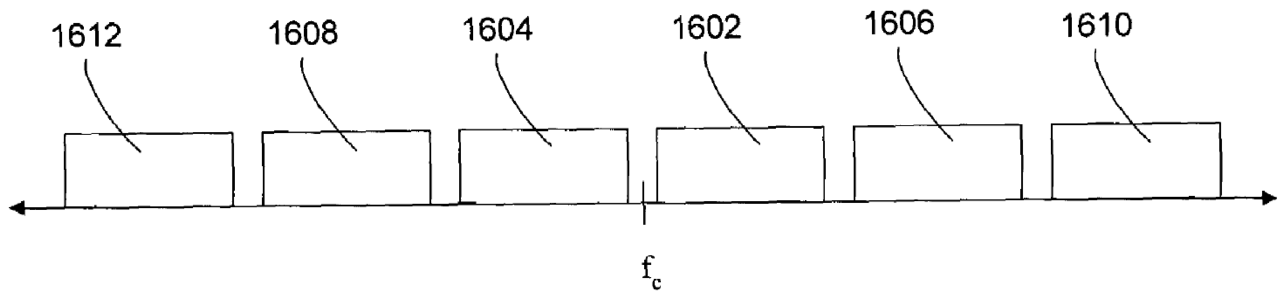 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[14.3] receiving the transmitted signal on a second antenna;	Shearer discloses "receiving the transmitted signal on a second antenna." See, e.g.:

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	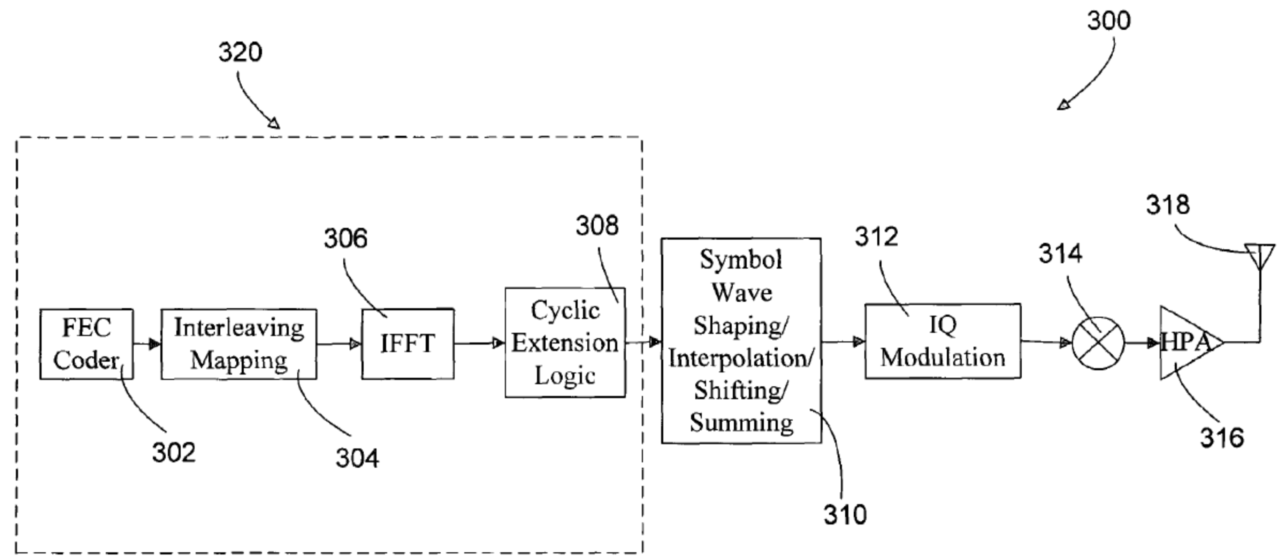 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 ("802.11") is set out in "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications" and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate "dead spots," and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See*, *e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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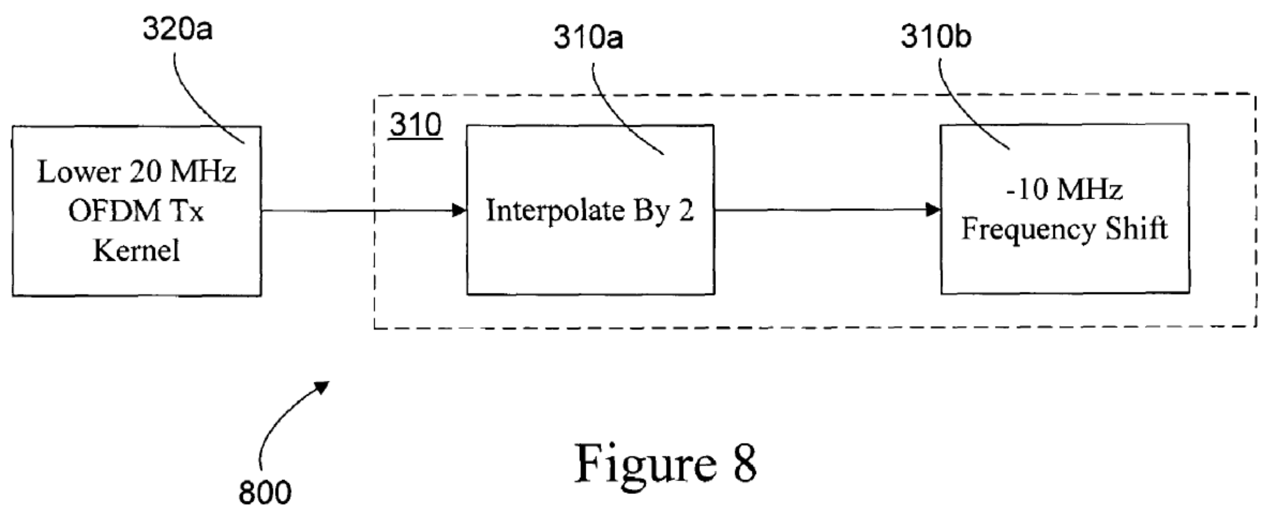
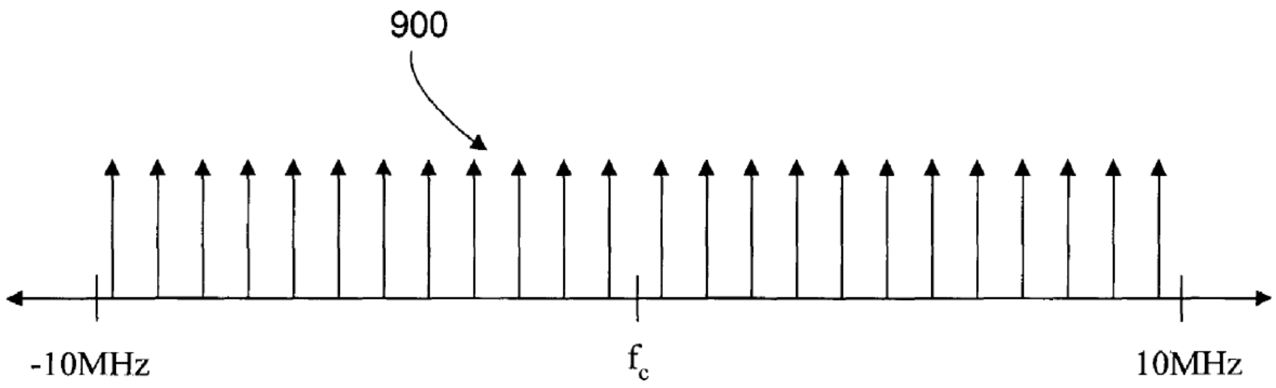
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

Claim 14 of the '802 Patent	**Prior Art Reference – Shearer**
	 Figure 9 *See, e.g.*, Shearer at Figure 9.

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	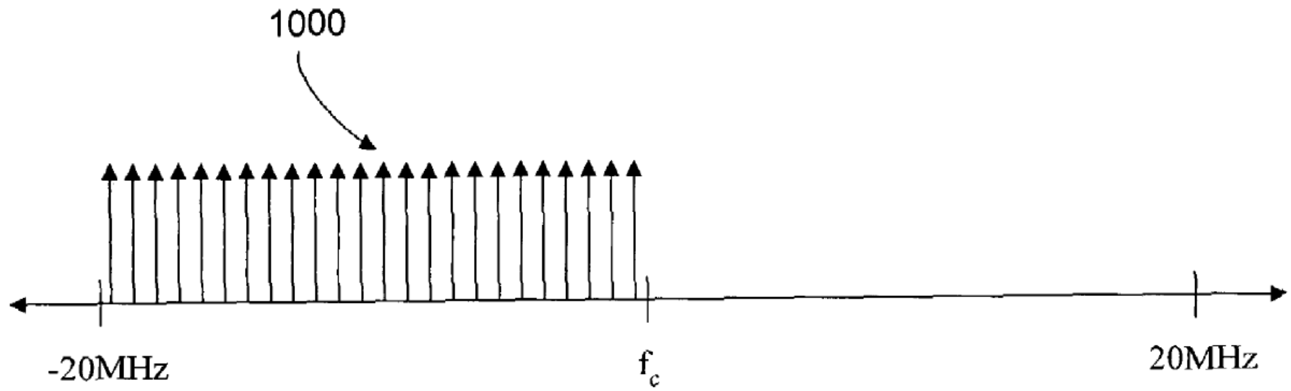 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

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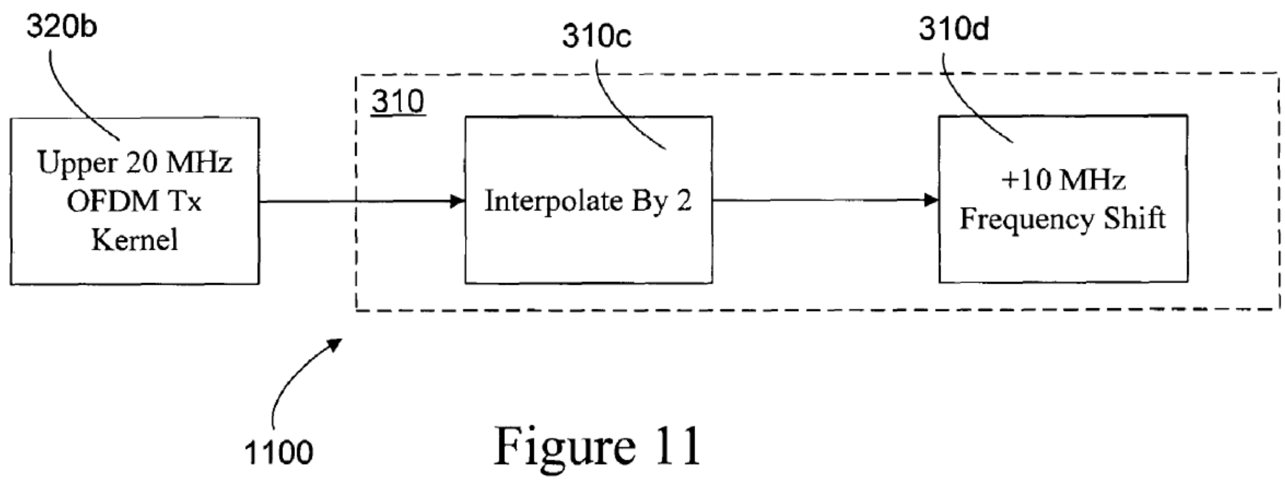
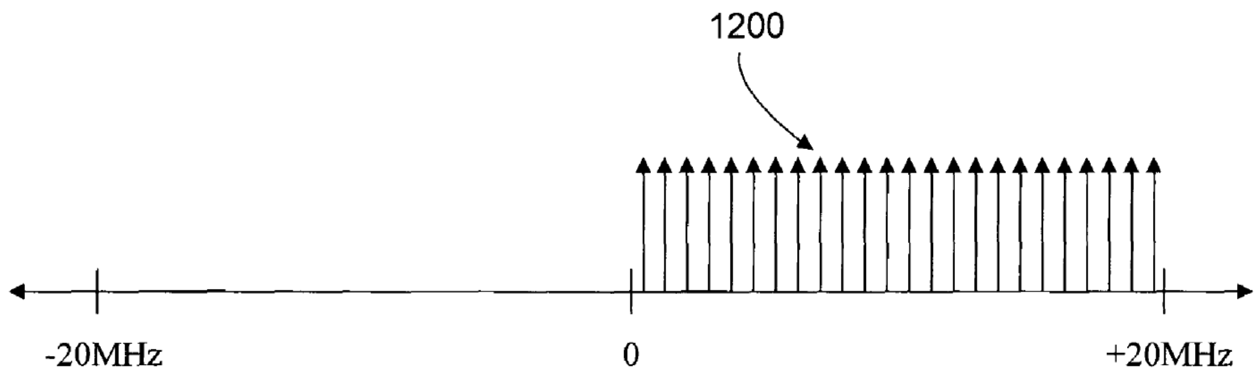
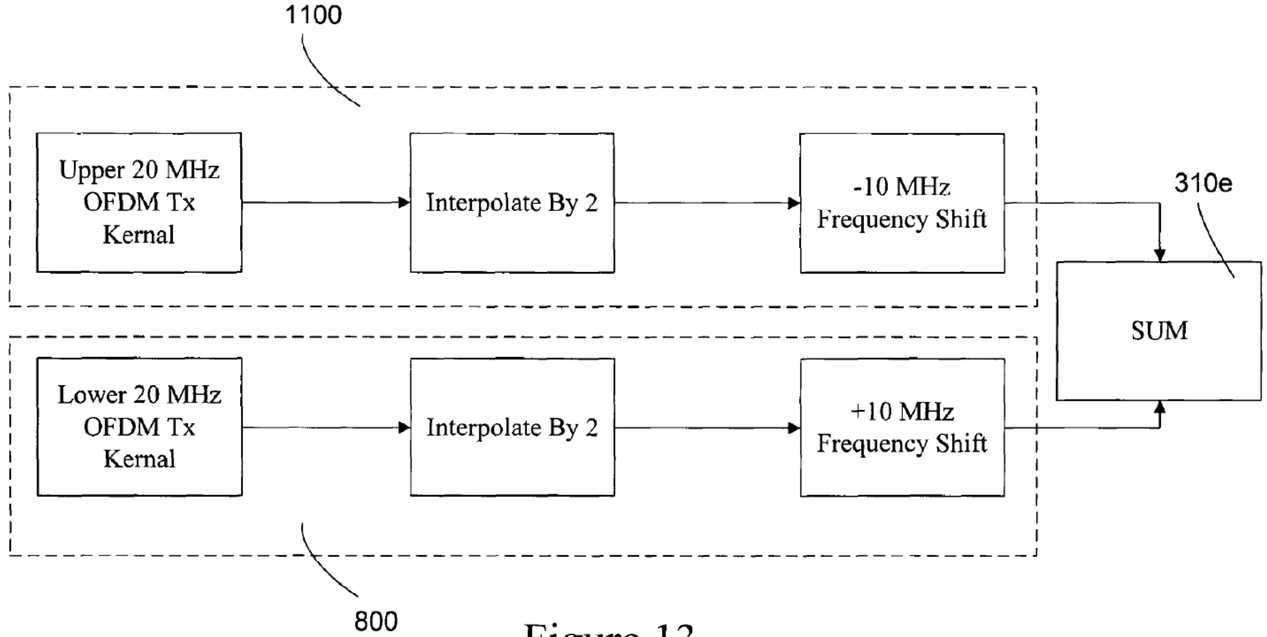
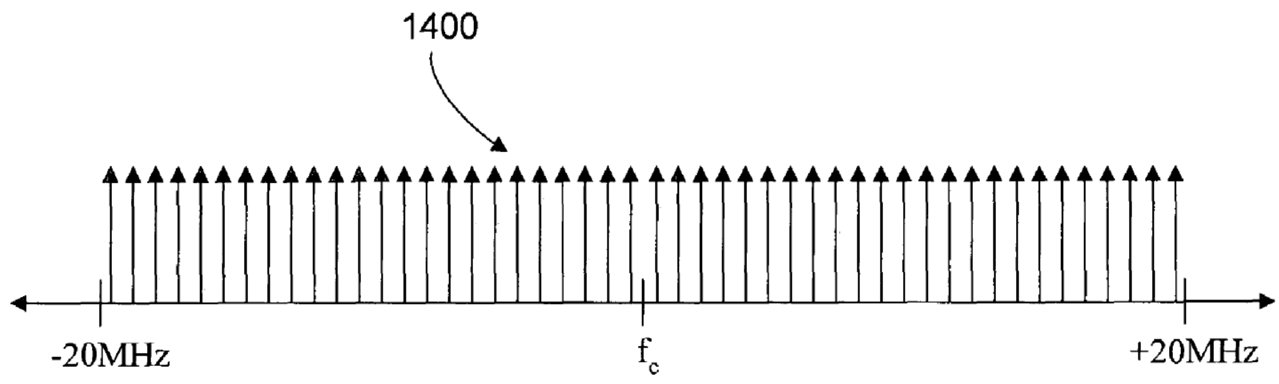
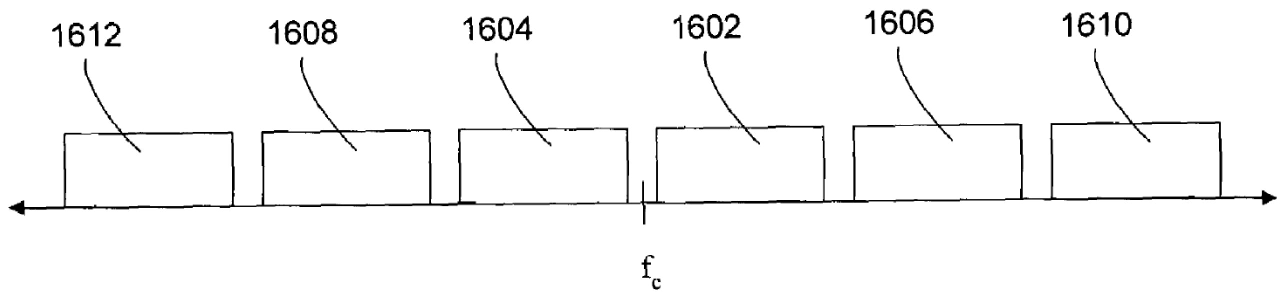
	 *See, e.g.*, Shearer at Figure 11.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 14 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 14 of the '802 Patent	**Prior Art Reference – Shearer**
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[14.4] amplifying the received signal in a low noise amplifier resulting in an amplified received up-converted signal, wherein the bandwidth of said low noise amplifier is greater than the difference between the lowest frequency in the	Shearer discloses "amplifying the received signal in a low noise amplifier resulting in an amplified received up-converted signal, wherein the bandwidth of said low noise amplifier is greater than the difference between the lowest frequency in the first up-converted frequency range and the highest frequency in the second up-converted frequency range." See, e.g.:

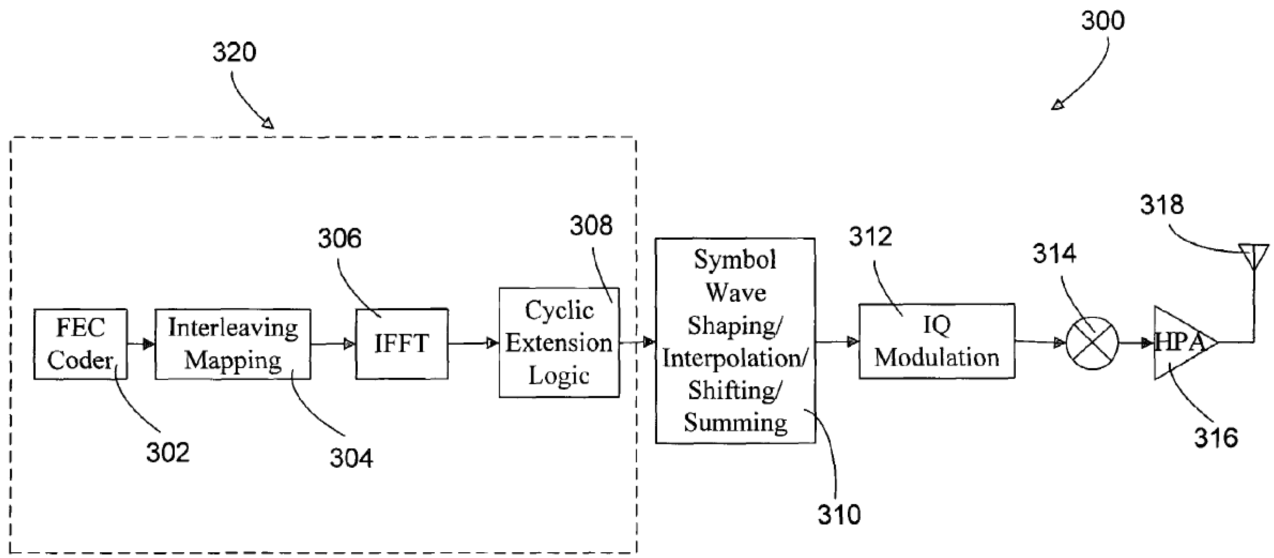
<table>
<tr><th>Claim 14 of the ’802 Patent</th><th>Prior Art Reference – Shearer</th></tr>
<tr><td>first up-converted frequency range and the highest frequency in the second up-converted frequency range;</td><td>

Figure 3

See, e.g., Shearer at Figure 3.

A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems.

Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within</td></tr>
</table>

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 ("802.11") is set out in "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications" and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate "dead spots," and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See*, *e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

Claim 14 of the ’802 Patent	Prior Art Reference – Shearer
	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

Claim 14 of the ’802 Patent	Prior Art Reference – Shearer
	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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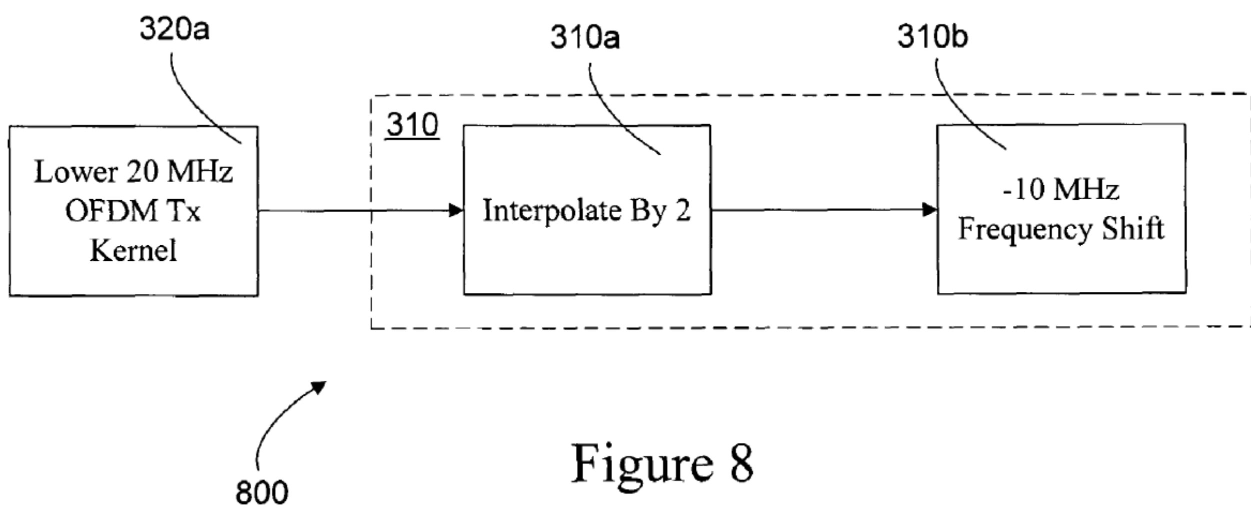
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See*, *e.g.*, Shearer at 9:25-54.  Figure 8 *See*, *e.g.*, Shearer at Figure 8.

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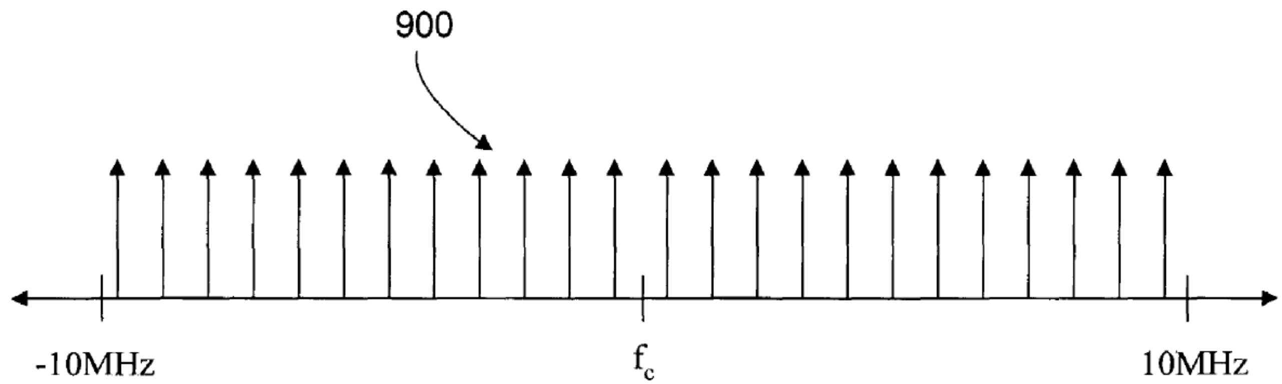
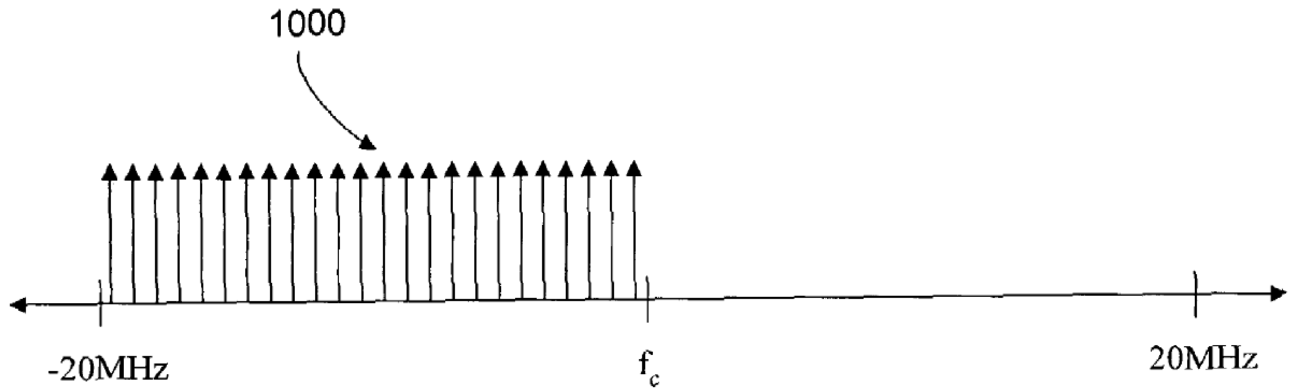
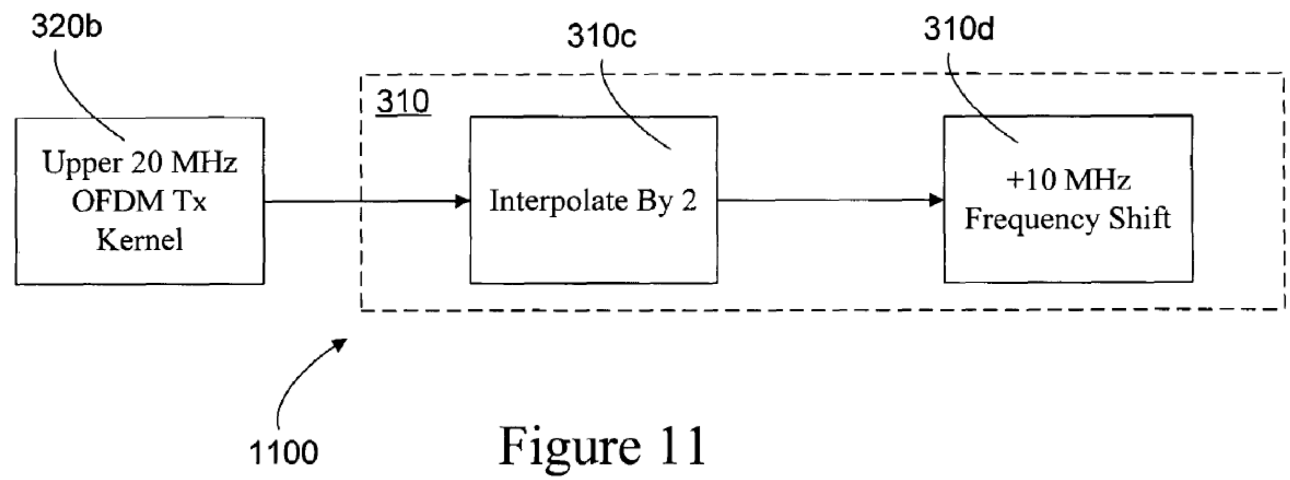
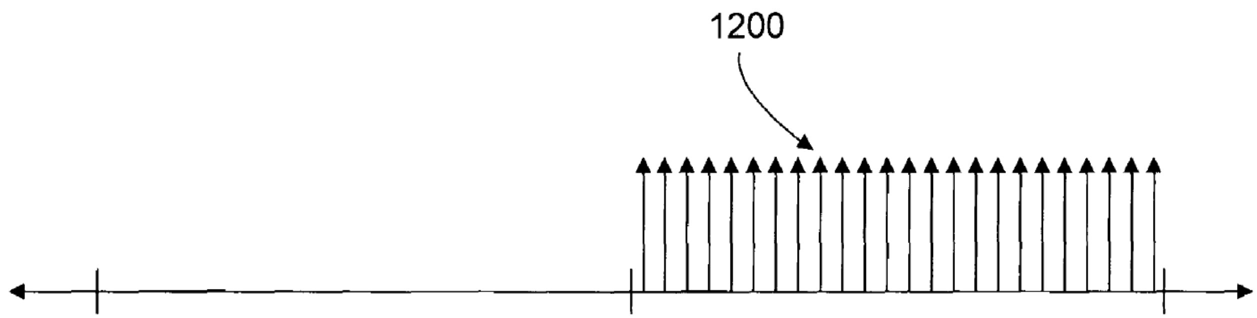
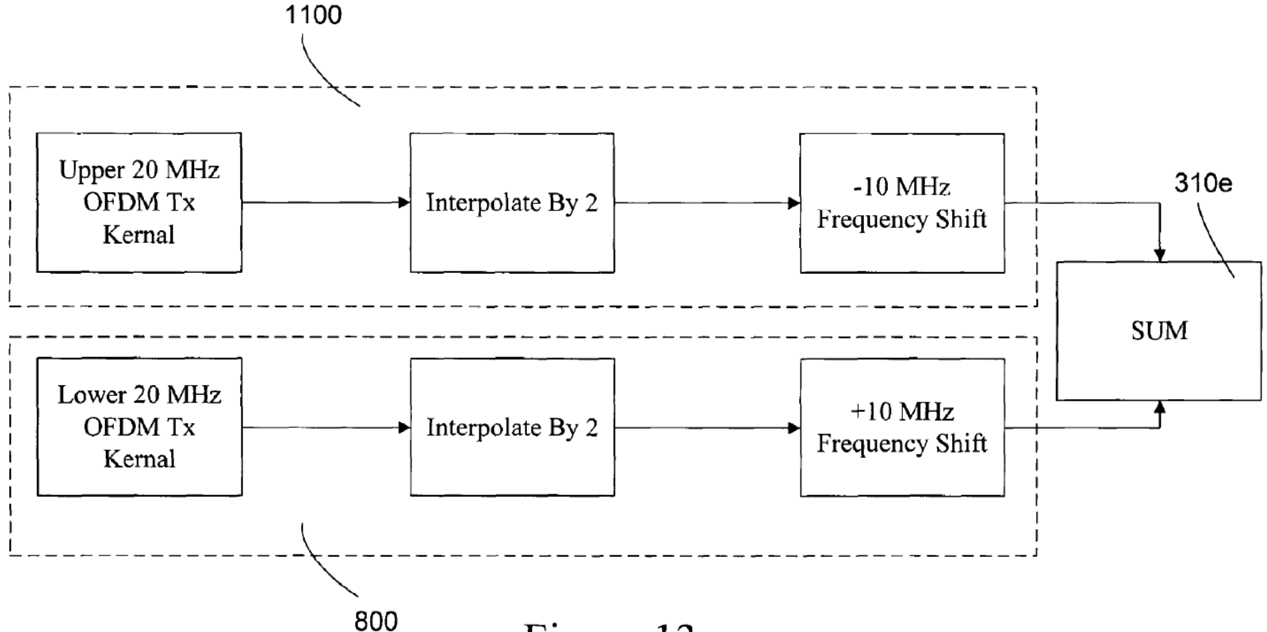
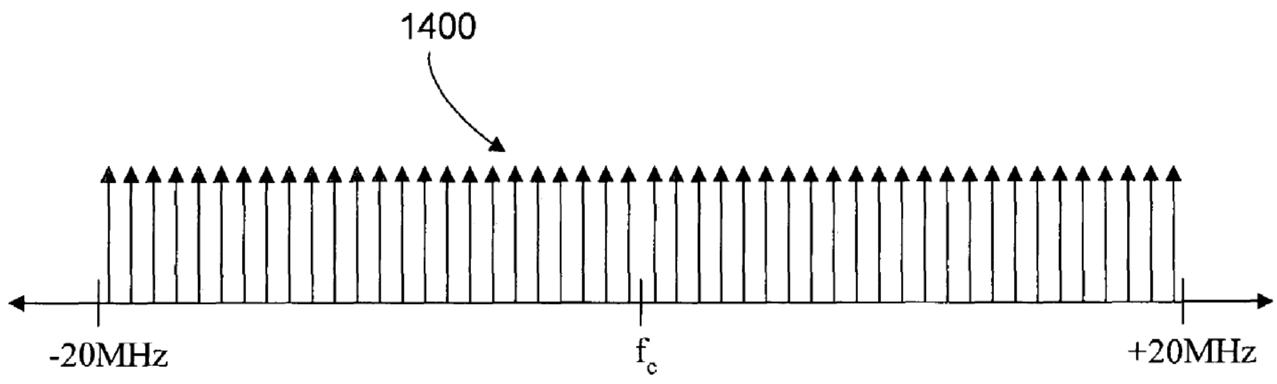
	 Figure 9 *See, e.g.*, Shearer at Figure 9.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See, e.g.*, Shearer at Figure 13.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

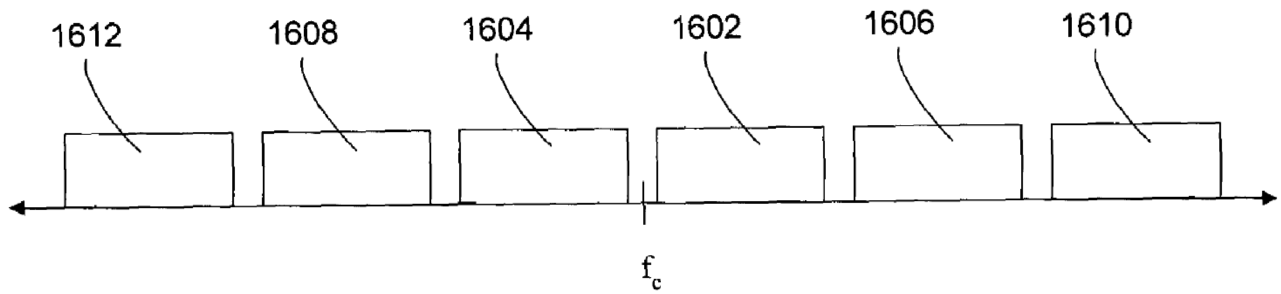
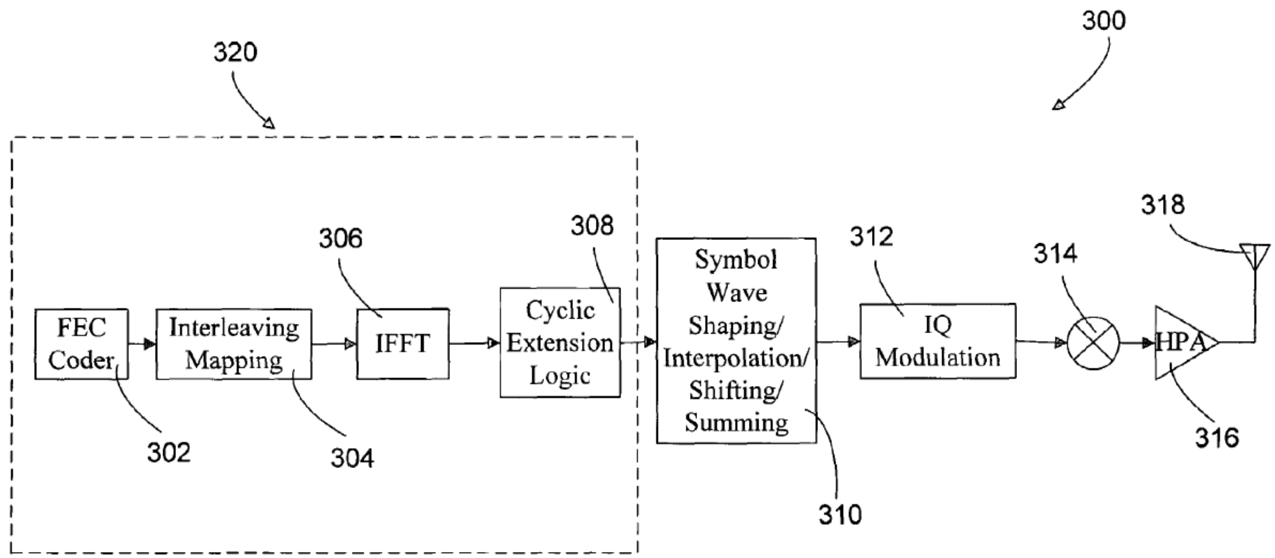
<table>
<tr><th>Claim 14 of the ’802 Patent</th><th>Prior Art Reference – Shearer</th></tr>
<tr><td></td><td>

Figure 16

See, e.g., Shearer at Figure 16.

Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.</td></tr>
<tr><td>[14.5] down-converting the amplified received up-converted signal using a first down-converter and a signal corresponding to the first RF center frequency to produce a fourth analog signal</td><td>Shearer discloses “down-converting the amplified received up-converted signal using a first down-converter and a signal corresponding to the first RF center frequency to produce a fourth analog signal corresponding to the first analog signal.” See, e.g.:</td></tr>
</table>

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
corresponding to the first analog signal; and	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

Claim 14 of the ’802 Patent	Prior Art Reference – Shearer
	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

Claim 14 of the ’802 Patent	Prior Art Reference – Shearer
	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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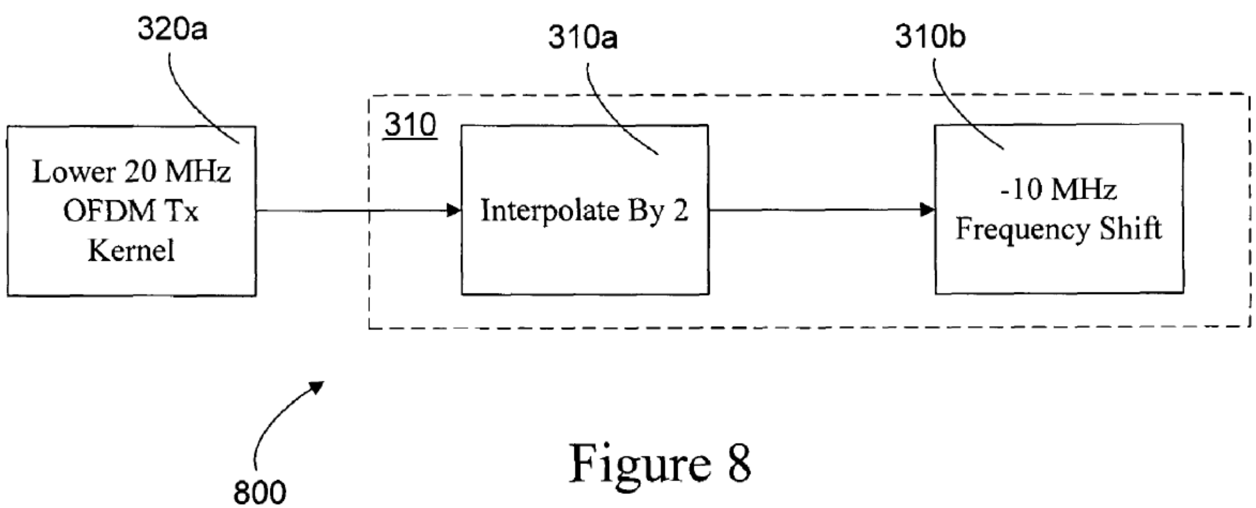
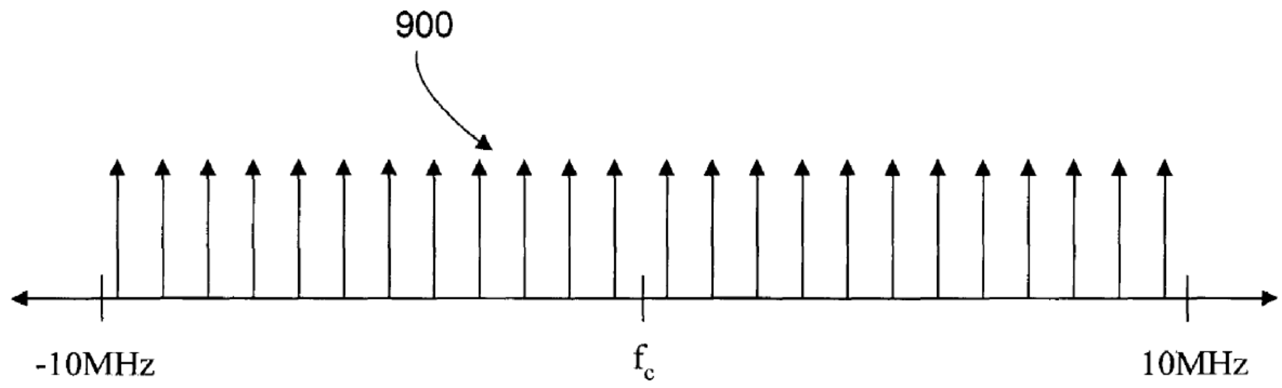
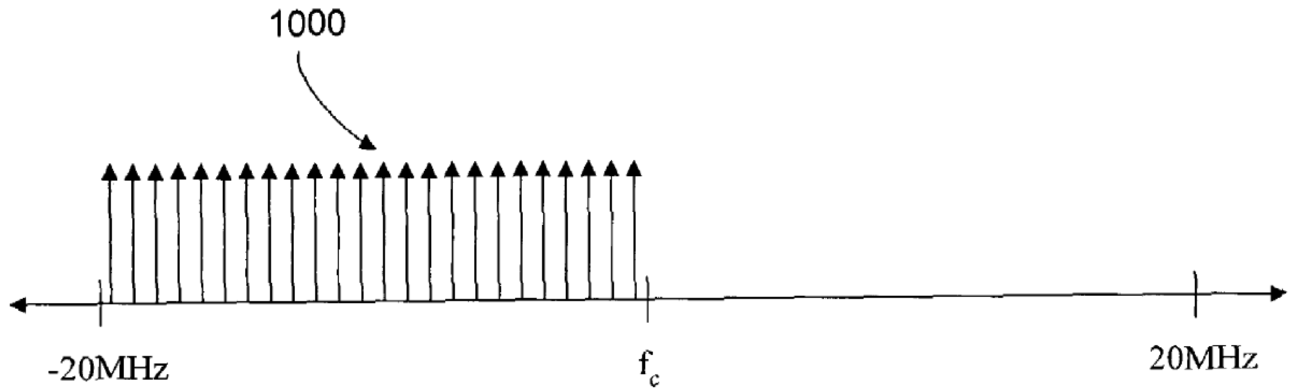
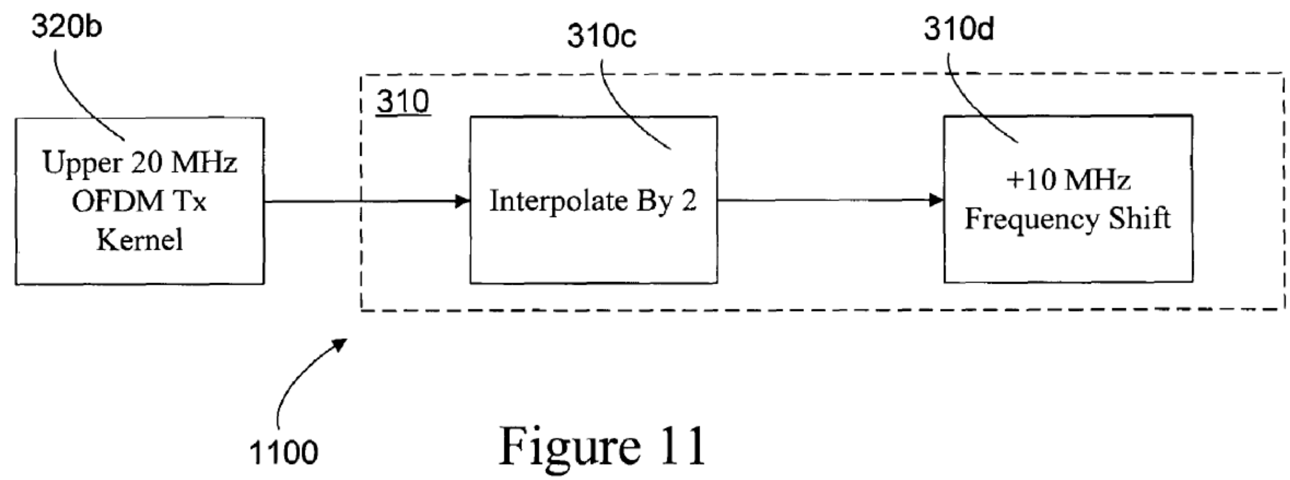
	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  *See, e.g.*, Shearer at Figure 8.

Claim 14 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See, e.g.*, Shearer at Figure 9.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

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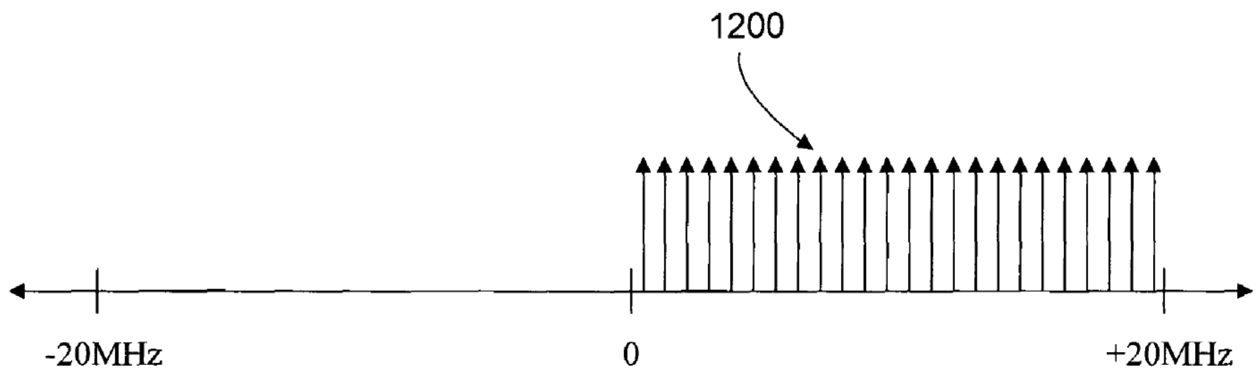
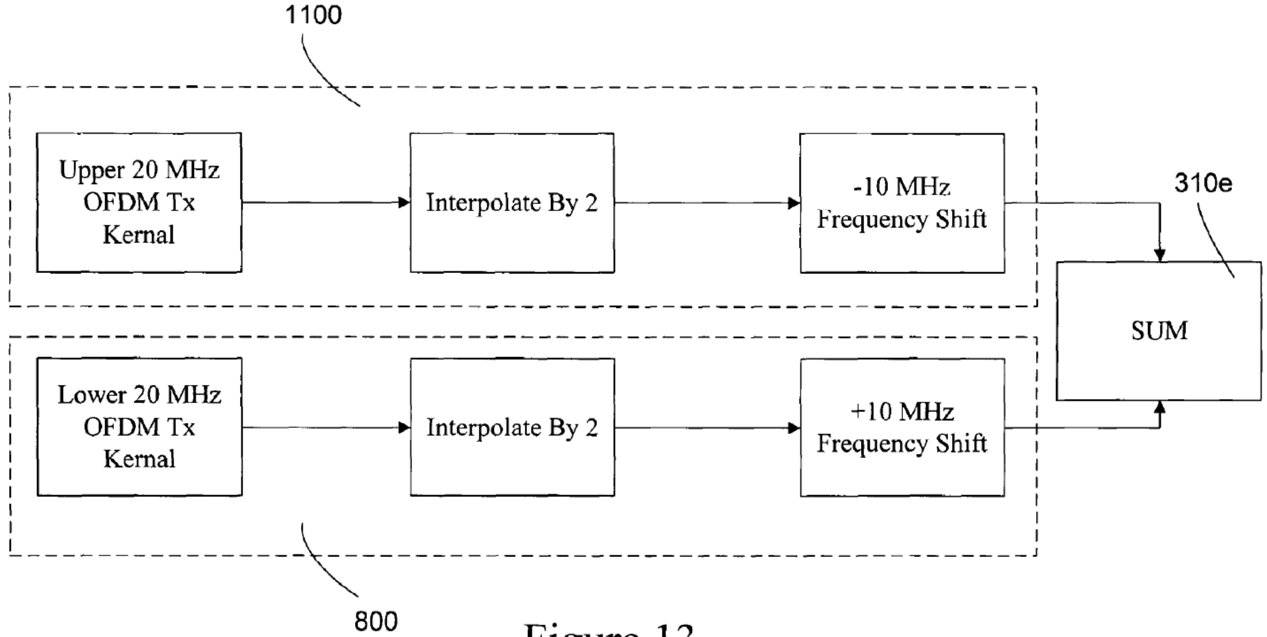
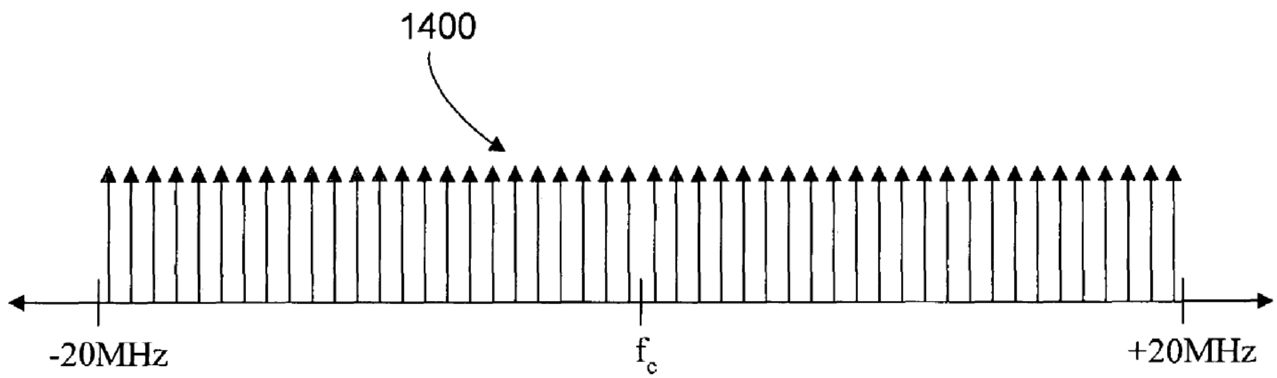
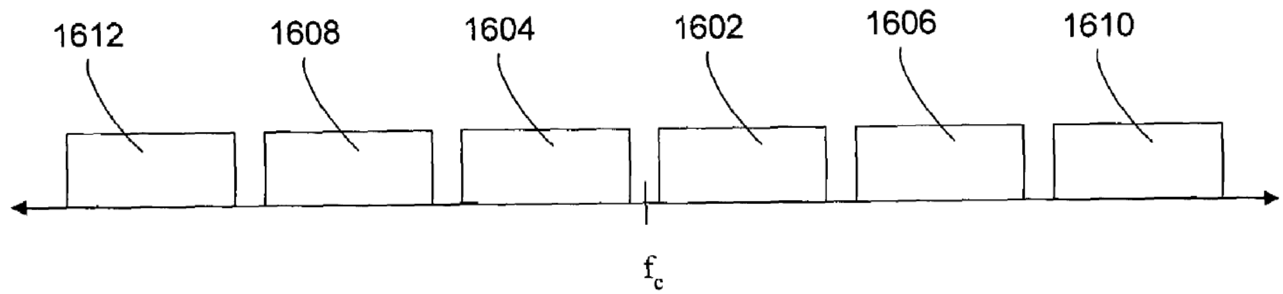
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[14.6] down-converting the amplified received up-converted analog signal using a second down-converter and a signal corresponding to the second RF center frequency to produce a fifth analog signal	Shearer discloses "down-converting the amplified received up-converted analog signal using a second down-converter and a signal corresponding to the second RF center frequency to produce a fifth analog signal corresponding to the second analog signal." See, e.g.:

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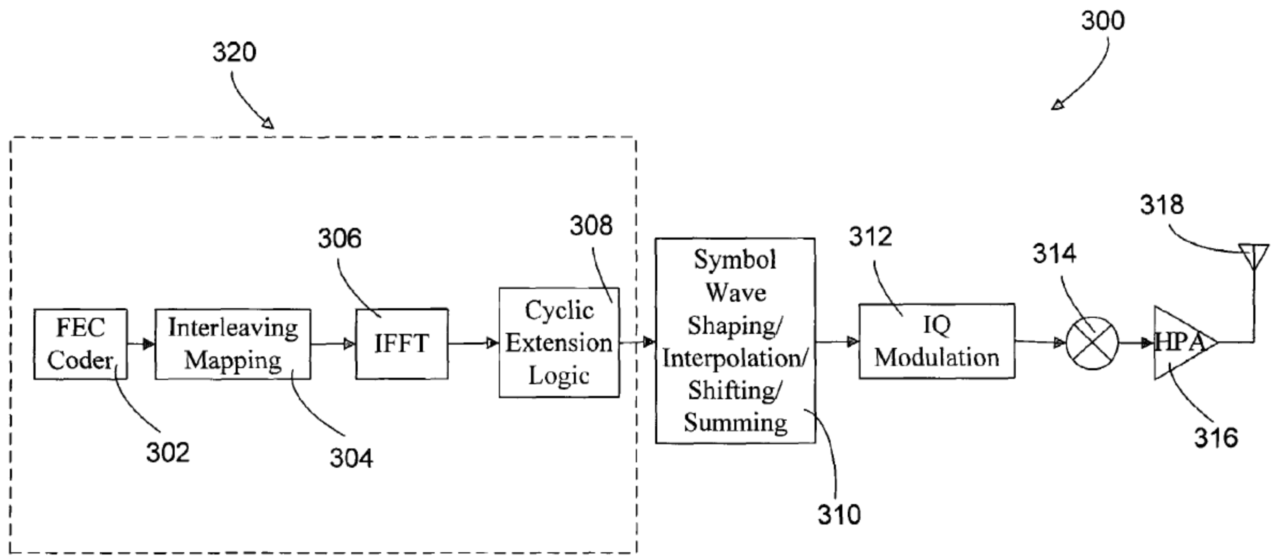
corresponding to the second analog signal.	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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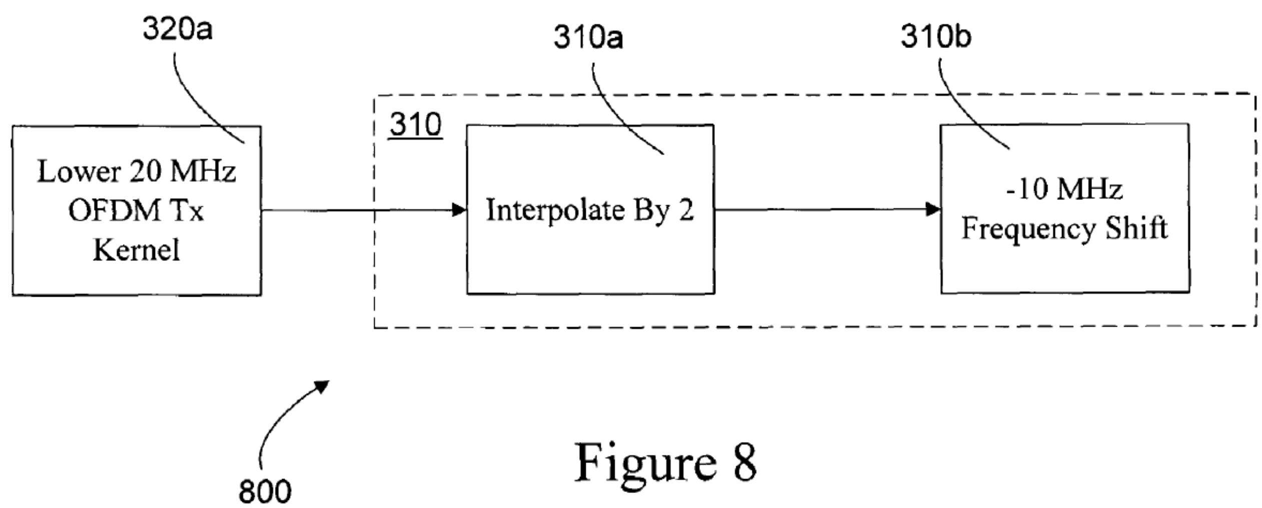
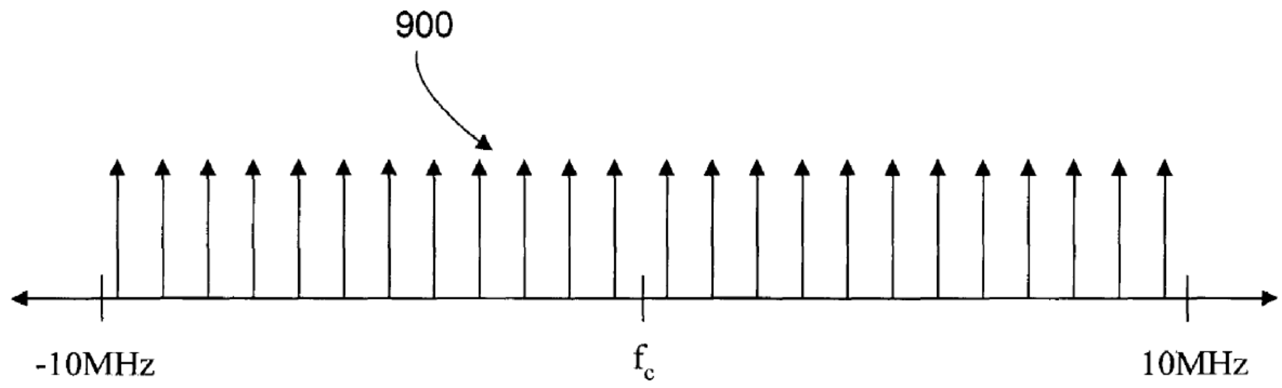
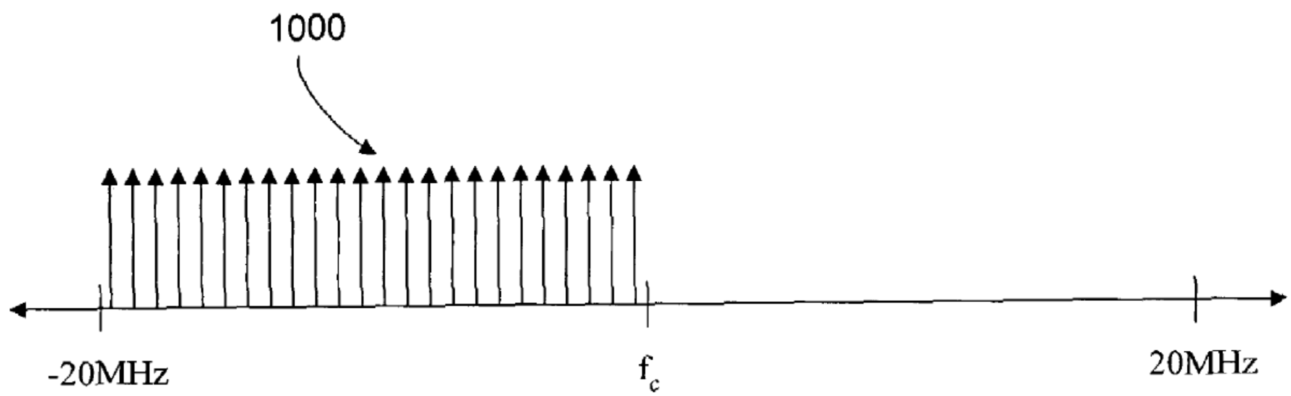
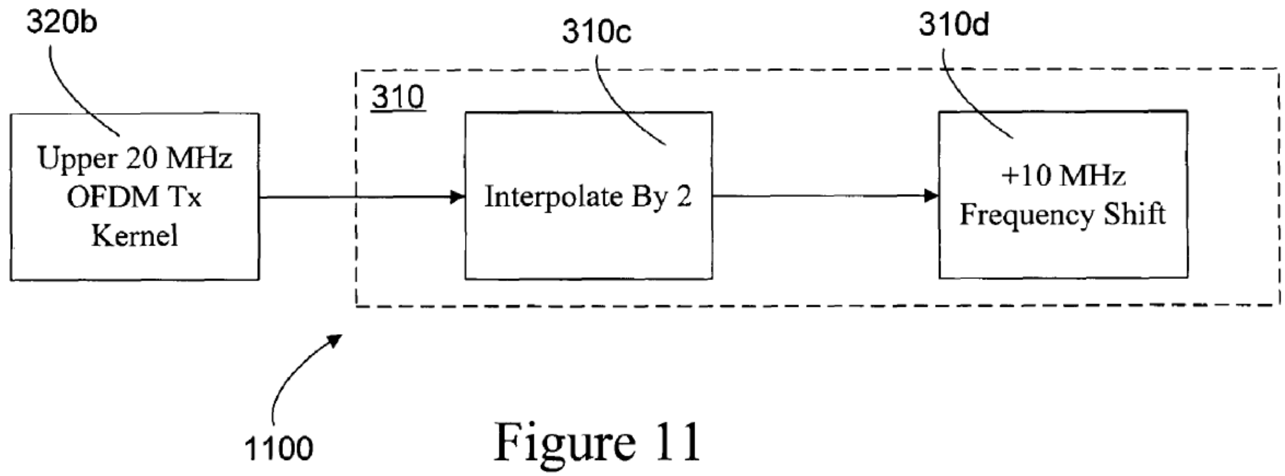
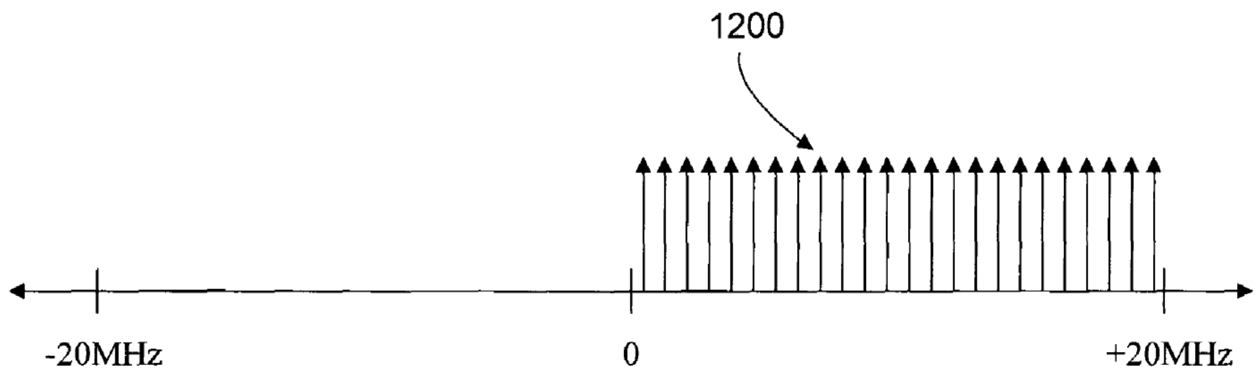
	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

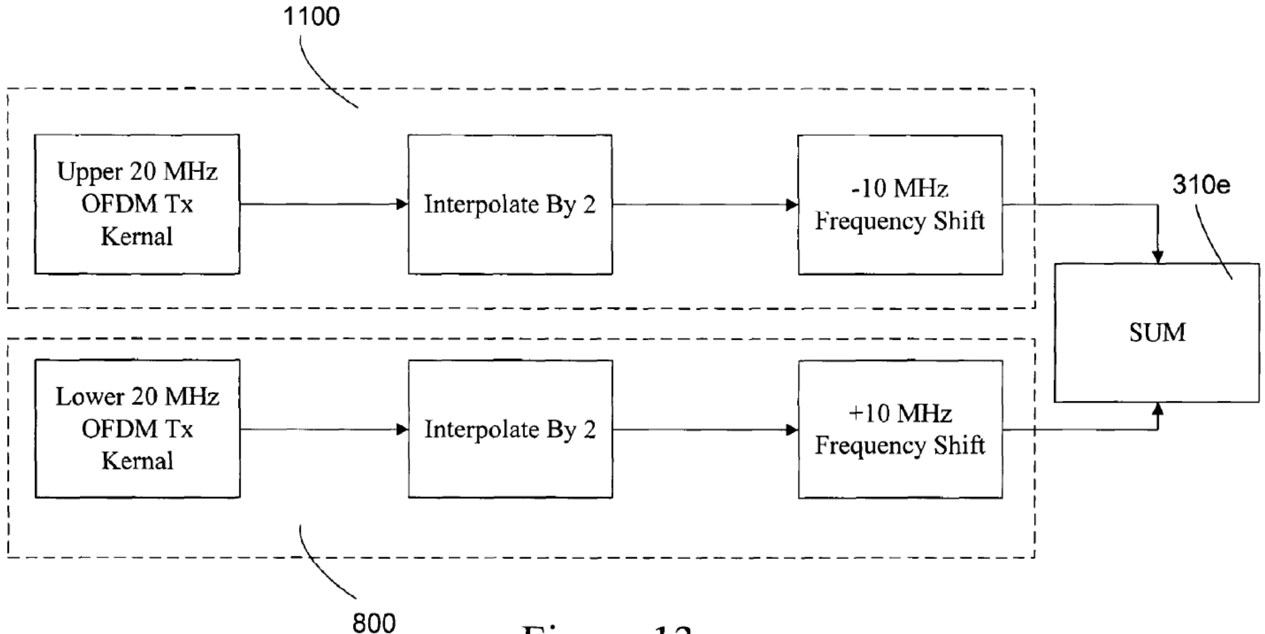
Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  *See, e.g.*, Shearer at Figure 8.

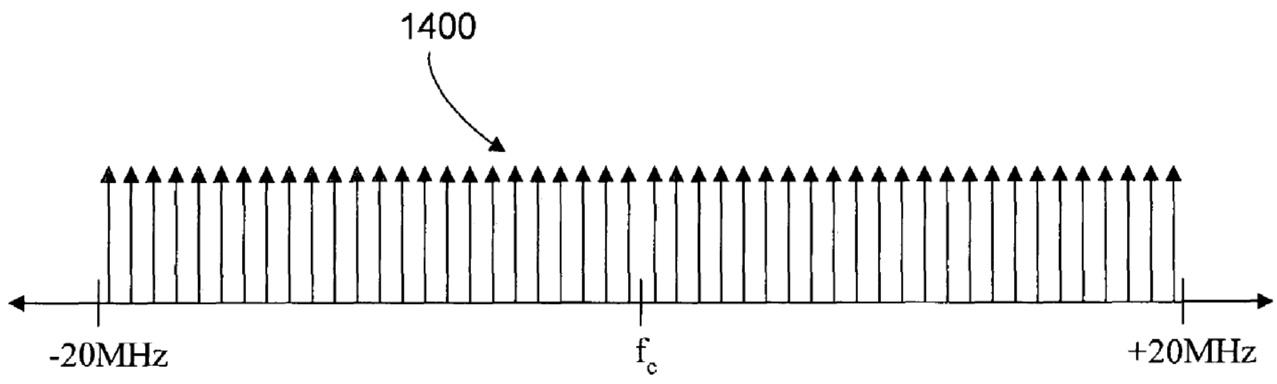
Claim 14 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See, e.g.*, Shearer at Figure 9.

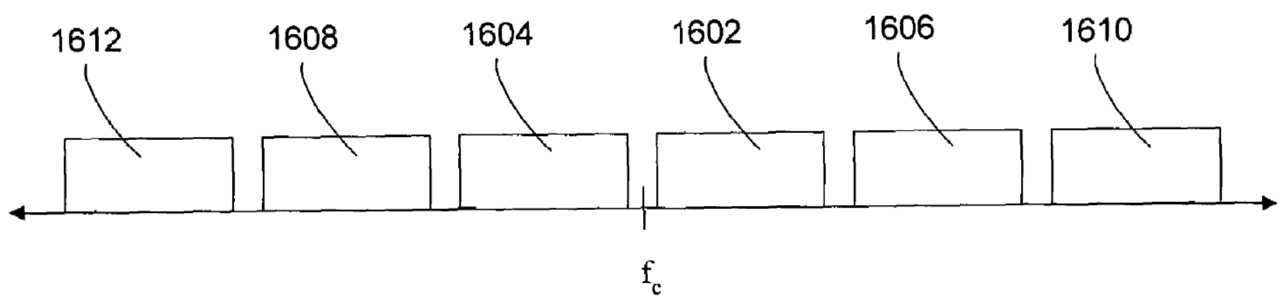
Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See*, *e.g.*, Shearer at Figure 11.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

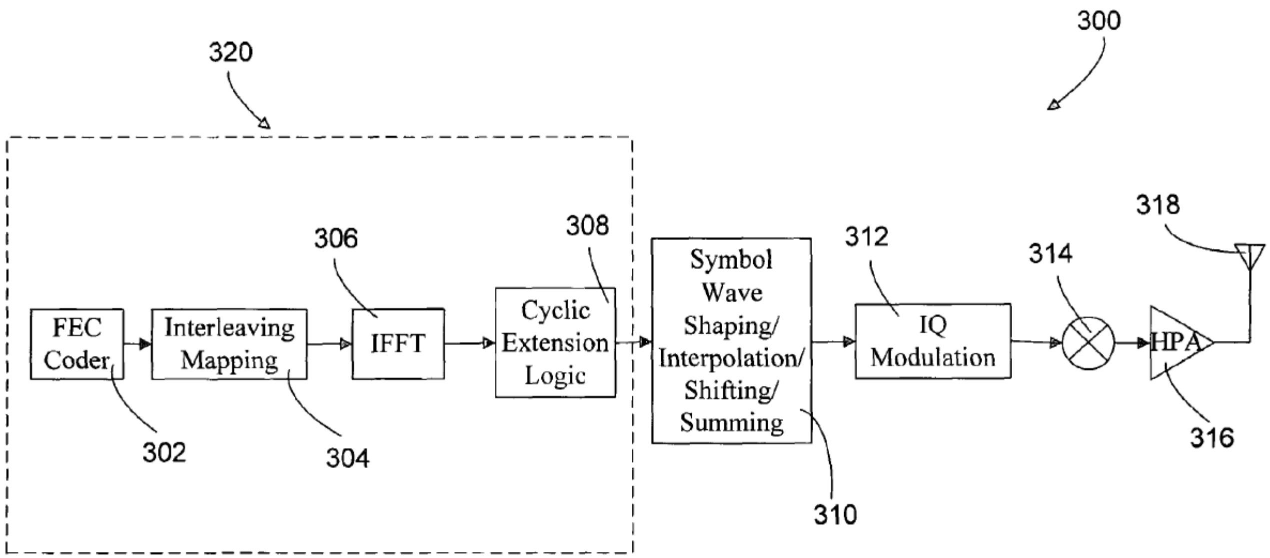
Claim 14 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 14 of the '802 Patent	**Prior Art Reference – Shearer**
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 17 of the '802 Patent	**Prior Art Reference – Shearer**
[17.1] A wireless communication system comprising:	To the extent the preamble is limiting, Shearer discloses "A wireless communication system comprising." See, e.g.:

Claim 17 of the ’802 Patent	**Prior Art Reference – Shearer**
	Disclosed herein are various embodiments of methods, systems, and apparatus for increasing packet generation in a digital communication system. In one exemplary method embodiment, subcarriers are added to a packet in a wireless local area network transmission to increase the data rate. *See, e.g.*, Shearer at Abstract. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. *See, e.g.*, Shearer at 1:31-38. 802.11 is directed to wireless LANs, and in particular specifies the MAC and the PHY layers. These layers are intended to correspond closely to the two lowest layers of a system based on the ISO Basic Reference Model of OSI, i.e., the data link layer and the physical layer. FIG. 1 shows a diagrammatic representation of an open systems interconnection (OSI) layered model 100 developed by the International Organization for Standards (ISO) for describing the exchange of information between layers in communication networks. The OSI layered model 100 is particularly useful for separating the technological functions of each layer, and thereby facilitating the modification or update of a given layer without detrimentally impacting on the functions of neighboring layers. *See, e.g.*, Shearer at 3:61-4:7. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308.

Claim 17 of the ’802 Patent	Prior Art Reference – Shearer
	See, e.g., Shearer at 4:62-5:4. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.2] a baseband digital system for providing a first digital signal comprising a first data to be transmitted and a second digital signal comprising a second data to be transmitted;	Shearer discloses “a baseband digital system for providing a first digital signal comprising a first data to be transmitted and a second digital signal comprising a second data to be transmitted.” See, e.g.:

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 ("802.11") is set out in "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications" and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate "dead spots," and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See*, *e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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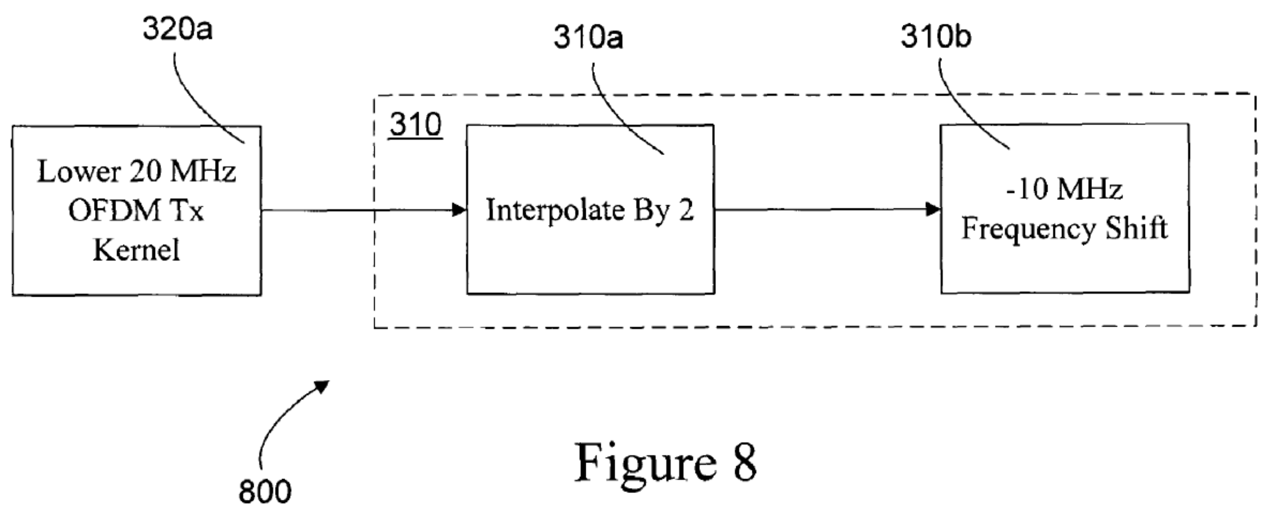
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  *See, e.g.*, Shearer at Figure 8.

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	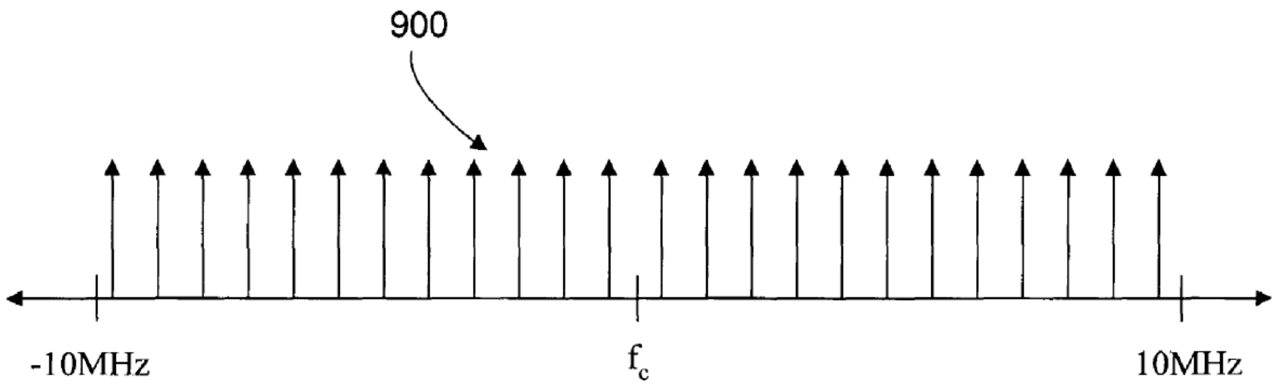 Figure 9 *See, e.g.*, Shearer at Figure 9.

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	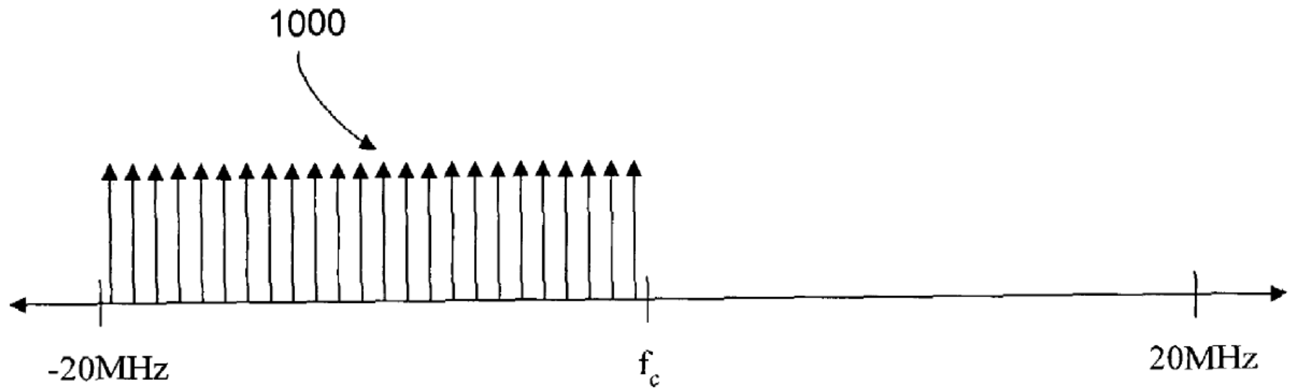 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

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	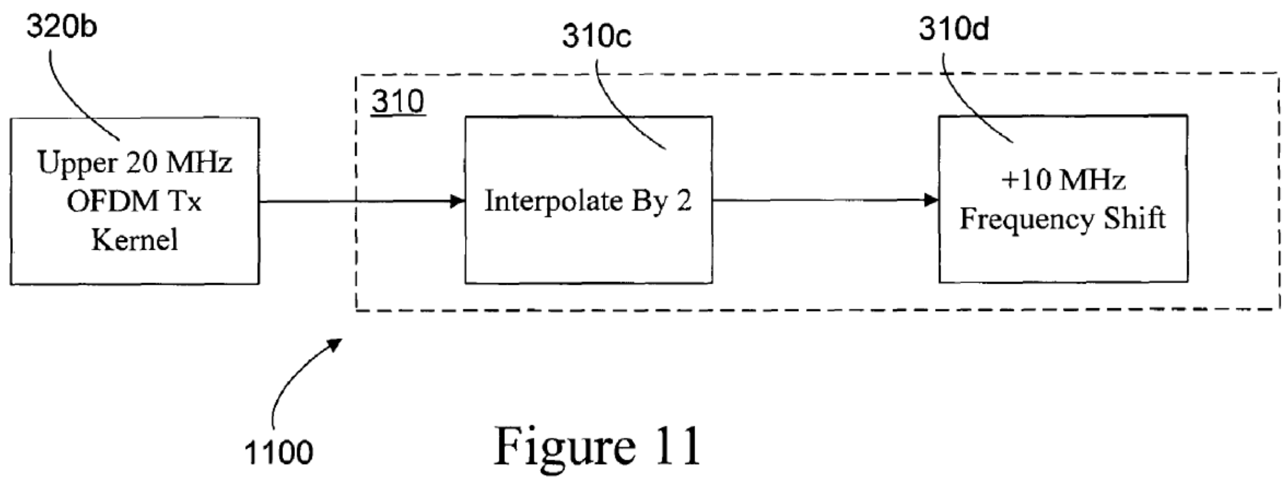 *See, e.g.*, Shearer at Figure 11.

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	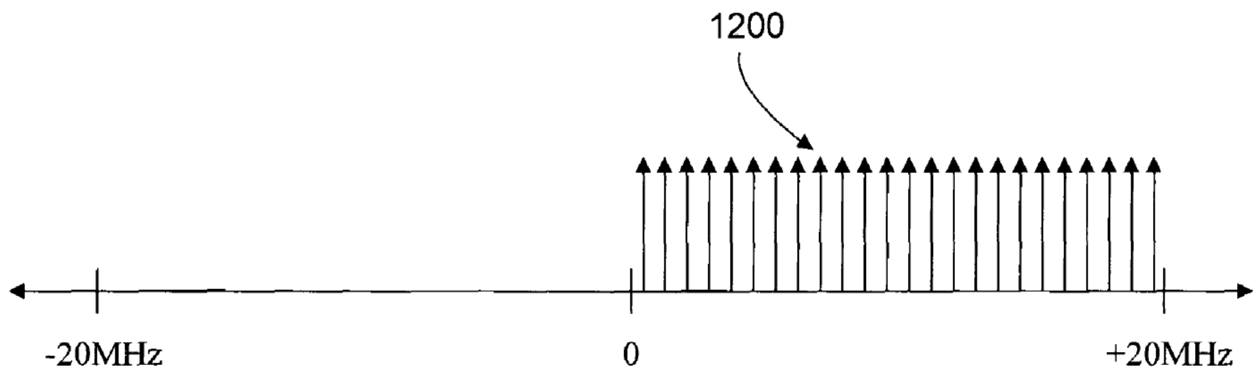 Figure 12 *See, e.g.*, Shearer at Figure 12.

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	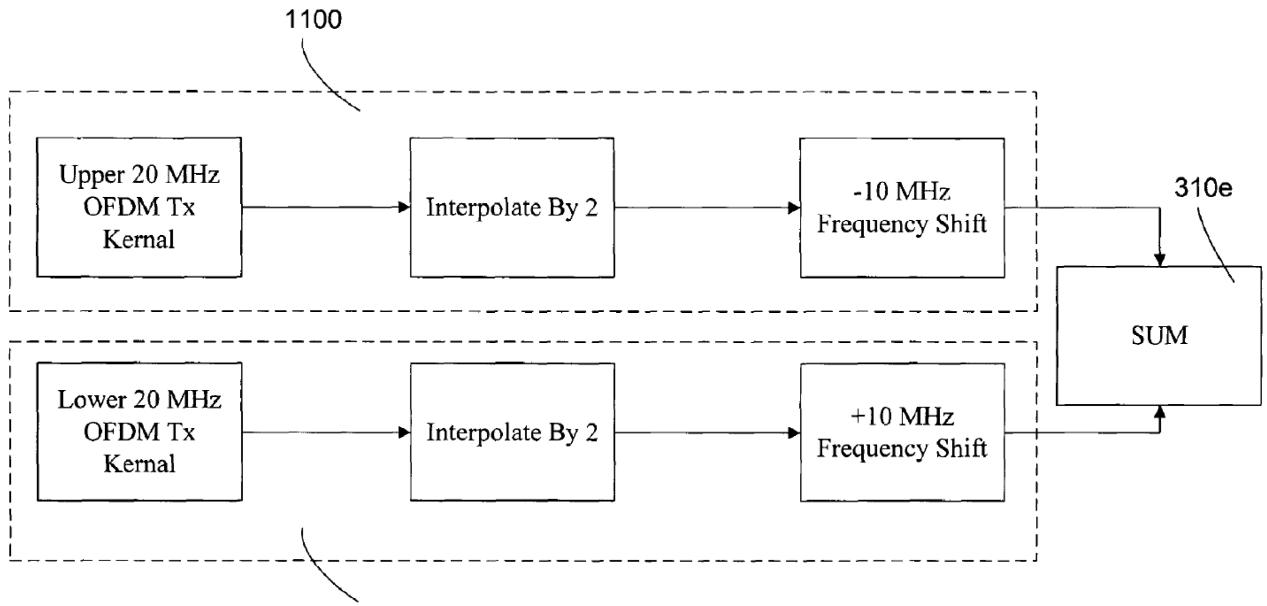 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

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	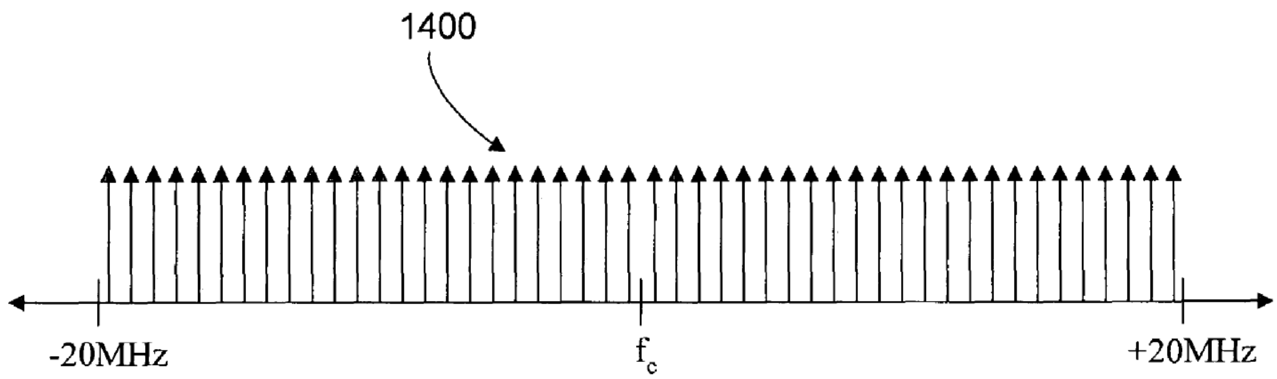 Figure 14 *See, e.g.*, Shearer at Figure 14.

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	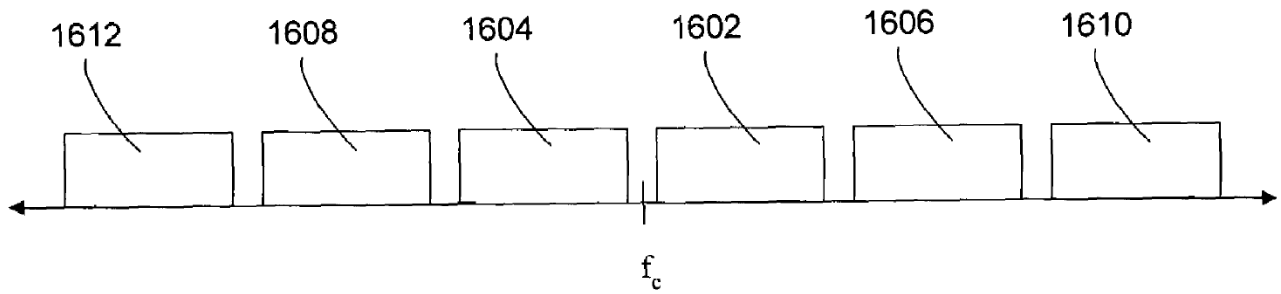 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.3] a first digital-to-analog converter for receiving the first digital signal and converting the first digital signal into a first analog signal, the first analog signal carrying the first data across a first frequency range;	Shearer discloses "a first digital-to-analog converter for receiving the first digital signal and converting the first digital signal into a first analog signal, the first analog signal carrying the first data across a first frequency range." See, e.g.:

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	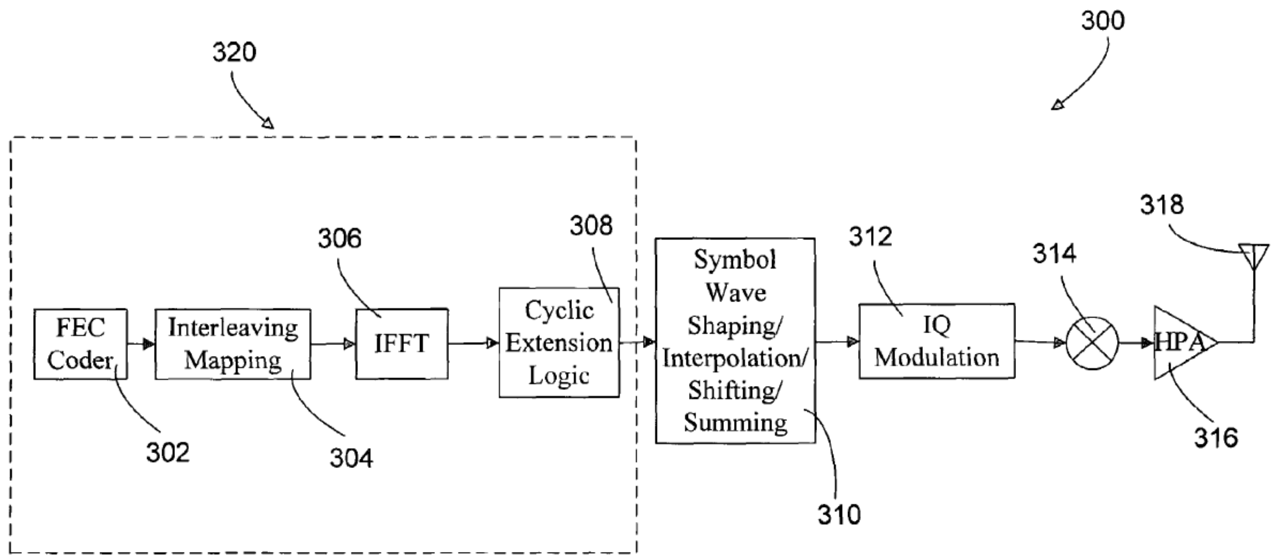 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See*, *e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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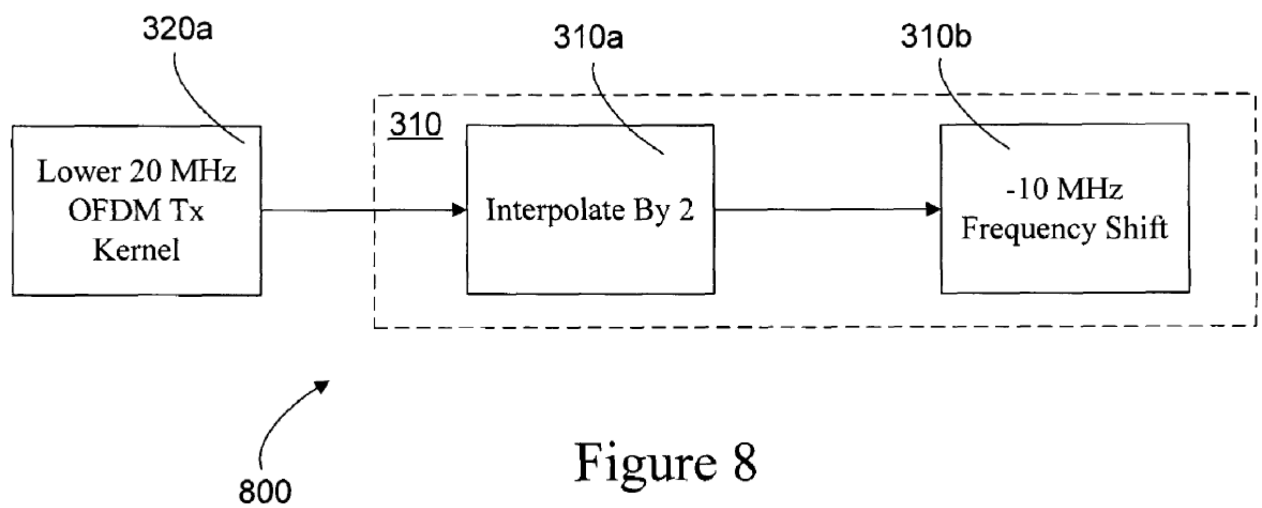
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See*, *e.g.*, Shearer at 9:25-54.  *See*, *e.g.*, Shearer at Figure 8.

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	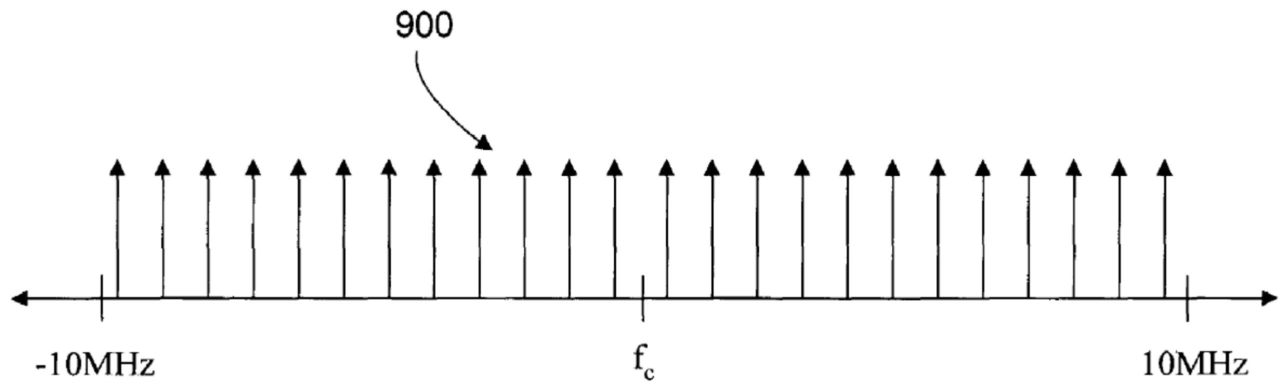 Figure 9 *See, e.g.*, Shearer at Figure 9.

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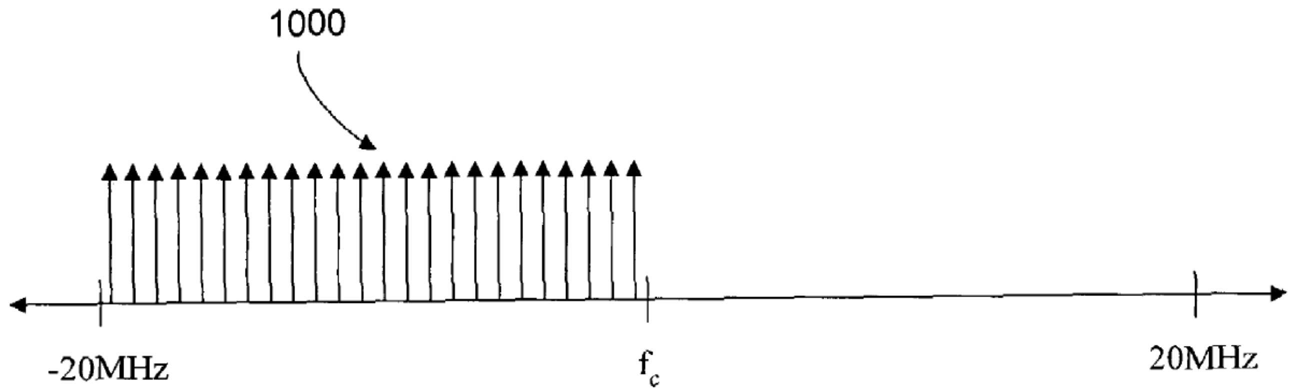
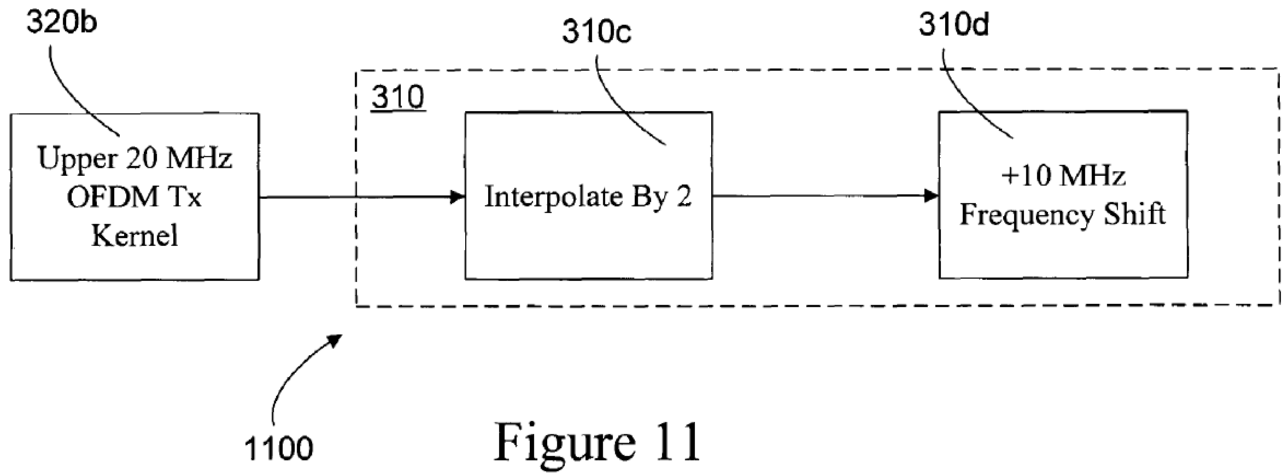
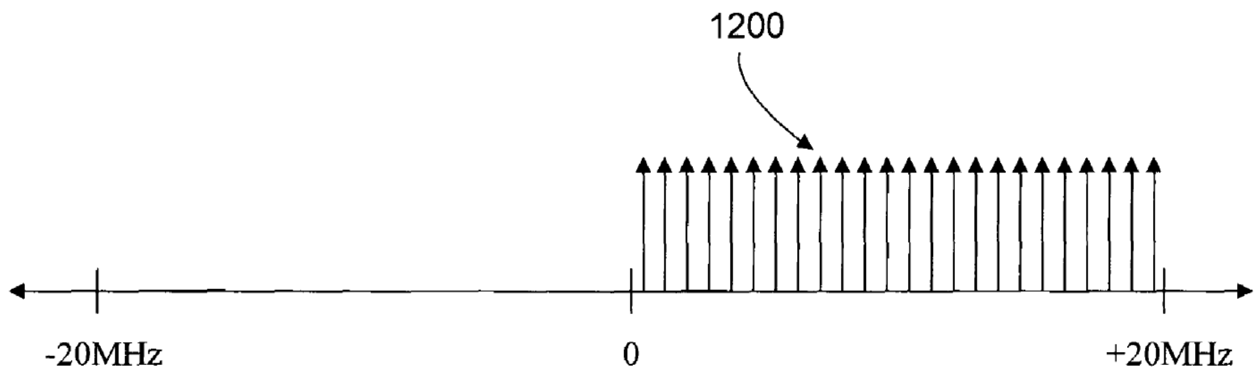
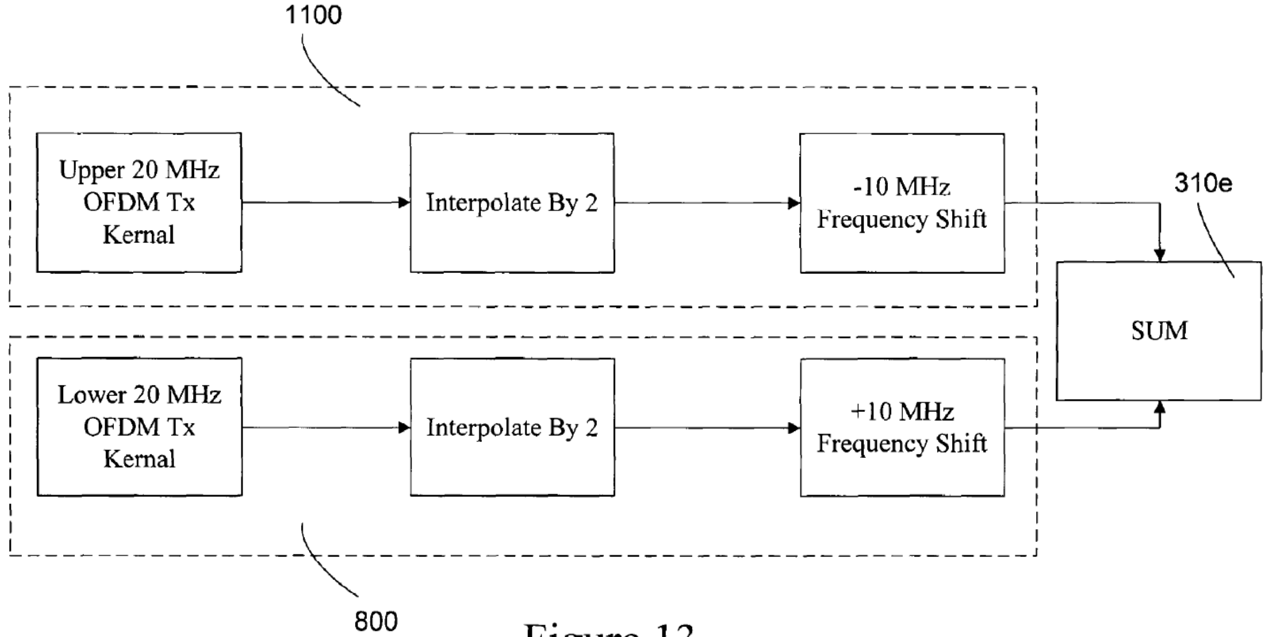
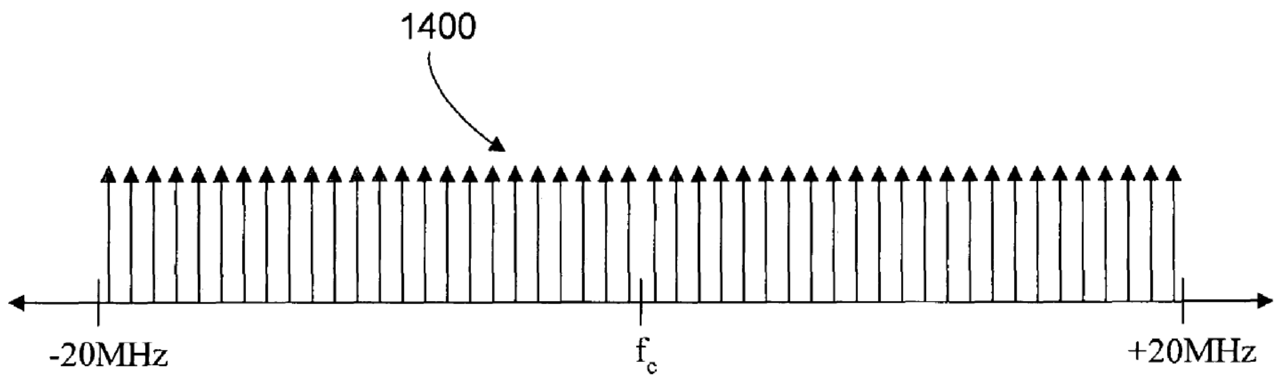
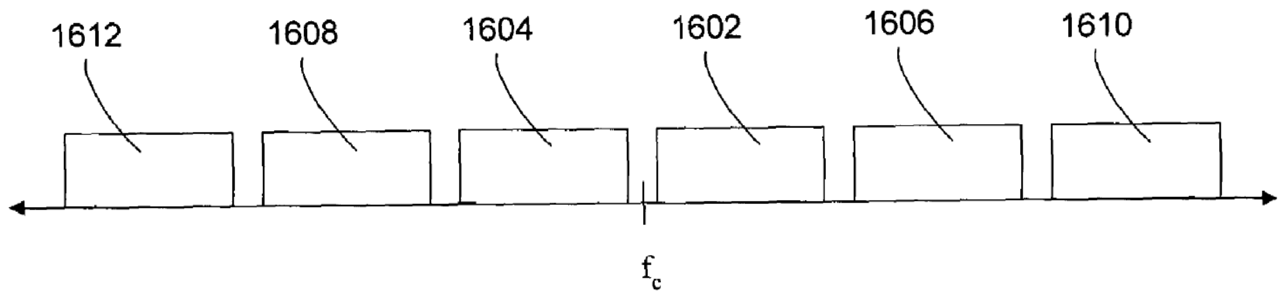
	 Figure 10 *See, e.g.*, Shearer at Figure 10.

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.4] a second digital-to-analog converter for receiving the second digital signal and converting the second digital signal into a second analog signal, the second analog signal carrying the second	Shearer discloses "a second digital-to-analog converter for receiving the second digital signal and converting the second digital signal into a second analog signal, the second analog signal carrying the second data across a second frequency range." See, e.g.:

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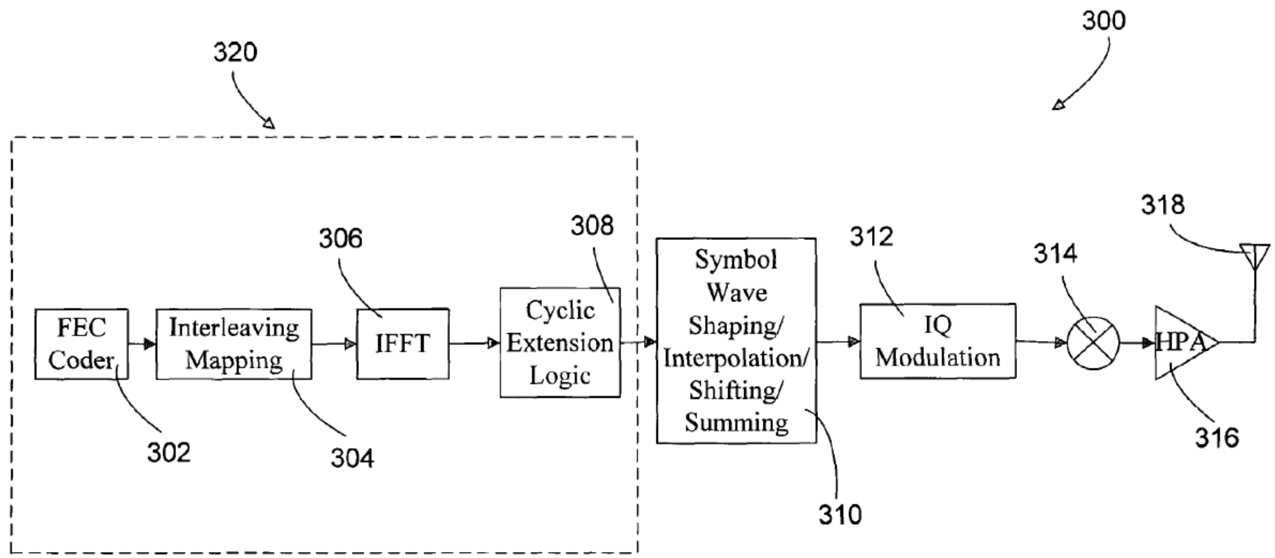
data across a second frequency range;	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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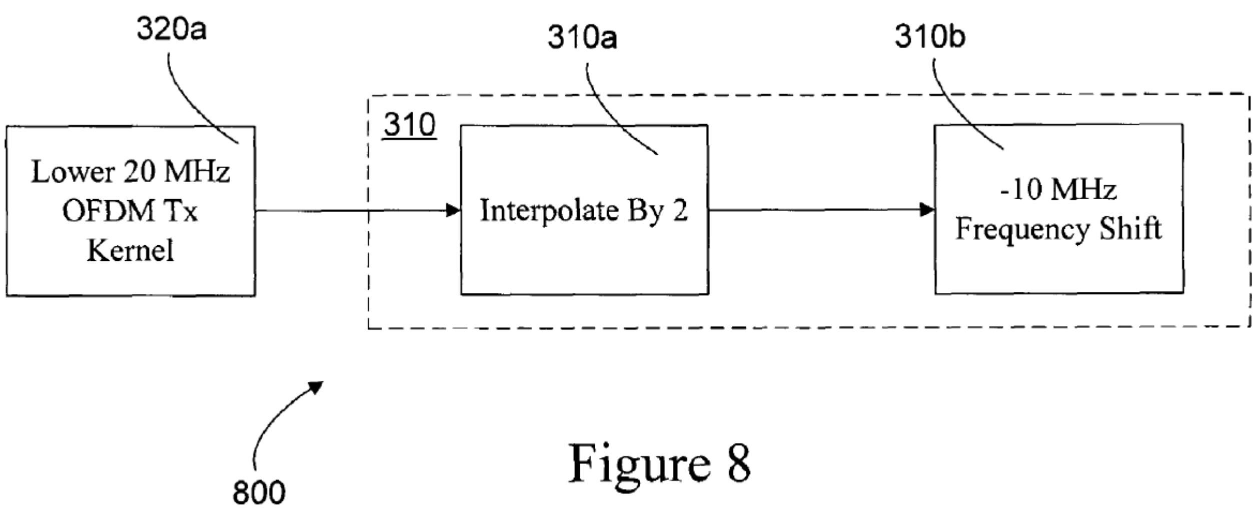
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See*, *e.g.*, Shearer at 9:25-54.  Figure 8 *See*, *e.g.*, Shearer at Figure 8.

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	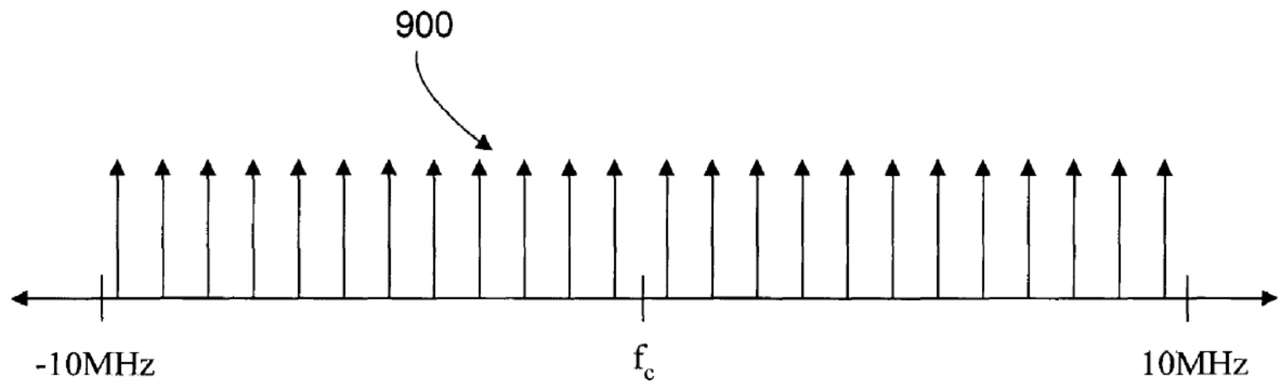 Figure 9 *See*, *e.g.*, Shearer at Figure 9.

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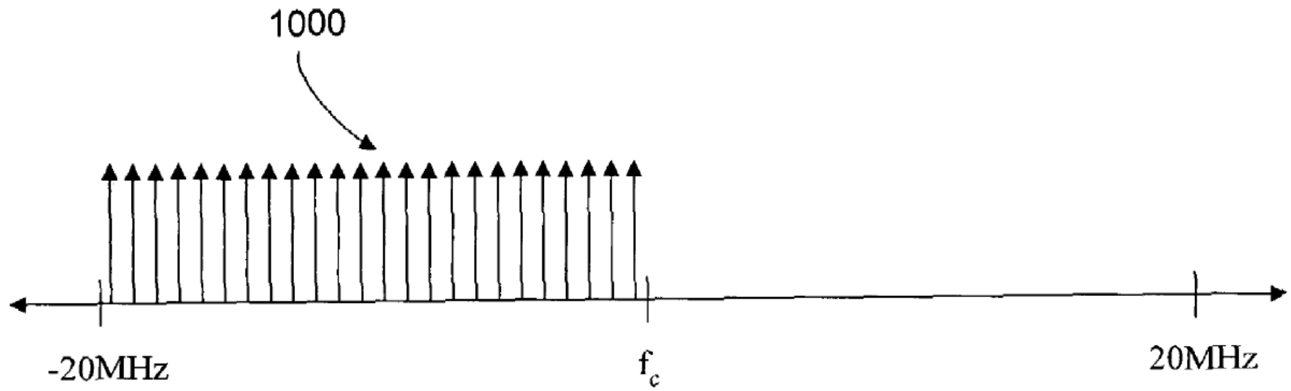
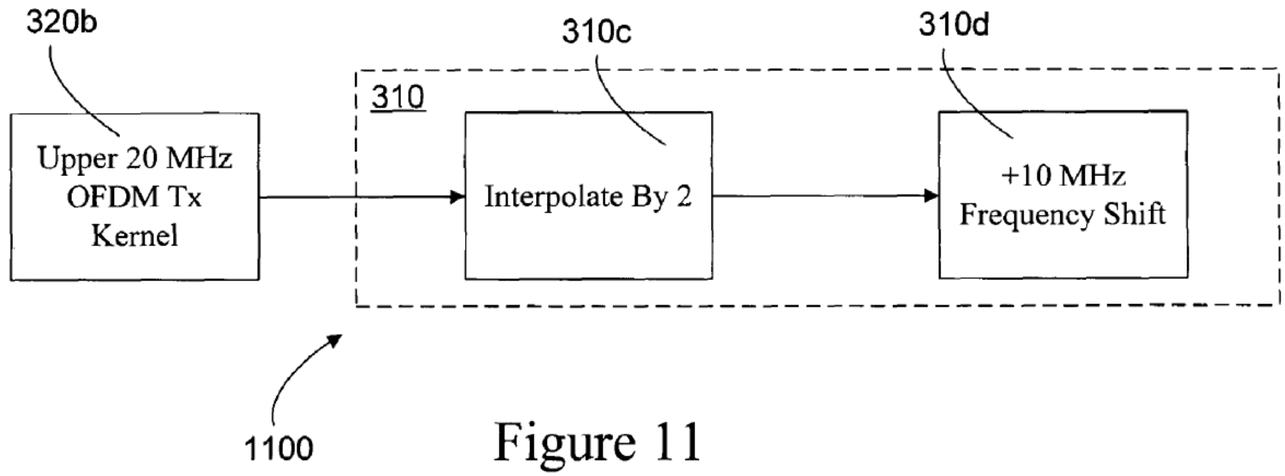
	 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

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	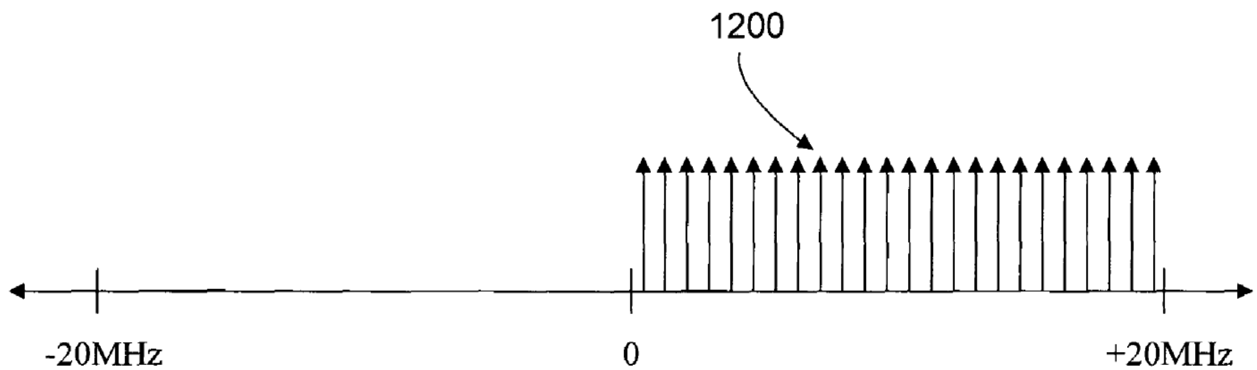 Figure 12 *See, e.g.*, Shearer at Figure 12.

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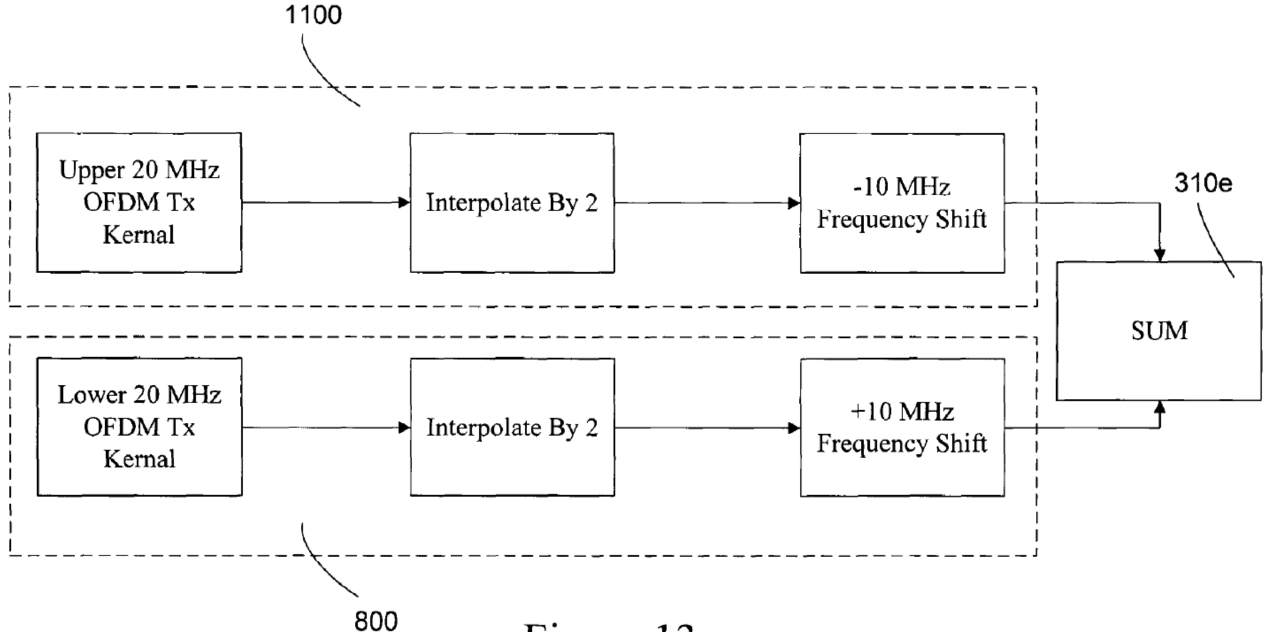
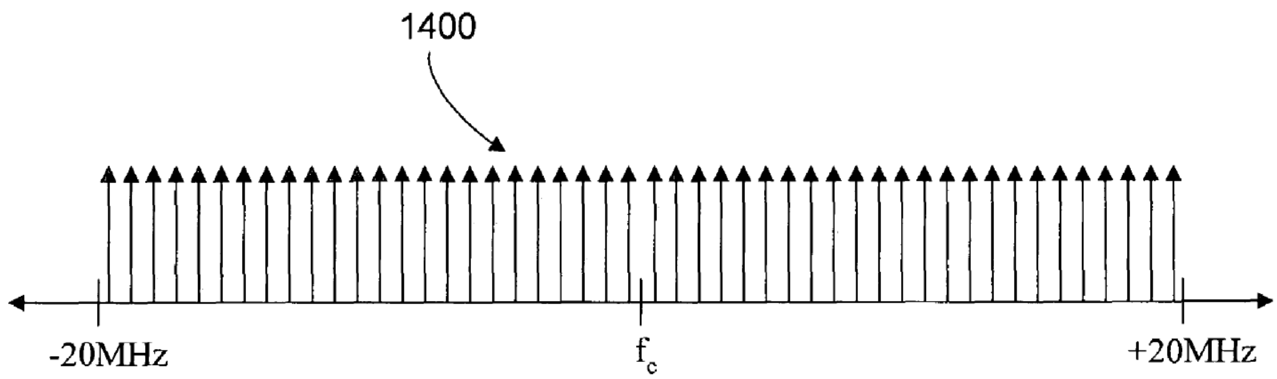
	 Figure 13 *See, e.g.*, Shearer at Figure 13.

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

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	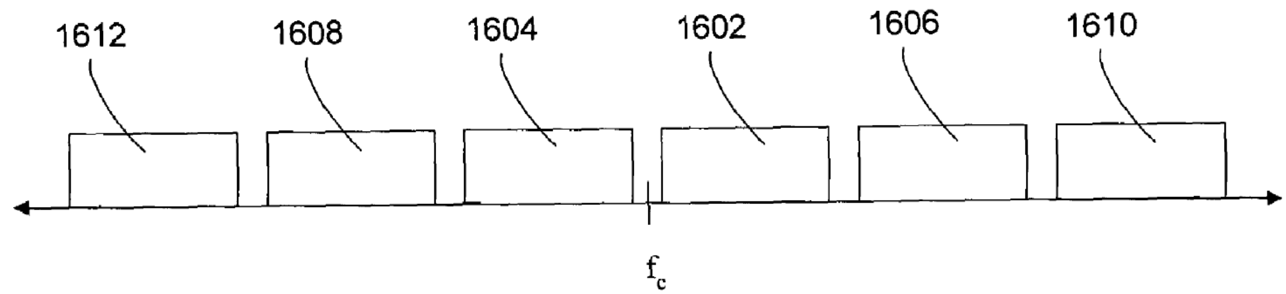 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.5] a first up-converter circuit having a first input coupled to receive the first analog signal and a second input coupled to receive a first modulation signal having a first RF frequency, wherein the first up-converter outputs	Shearer discloses "a first up-converter circuit having a first input coupled to receive the first analog signal and a second input coupled to receive a first modulation signal having a first RF frequency, wherein the first up-converter outputs a first up-converted analog signal comprising a first up-converted frequency range from the first RF frequency minus one-half the first frequency range to the first RF frequency plus one-half the first frequency range." See, e.g.:

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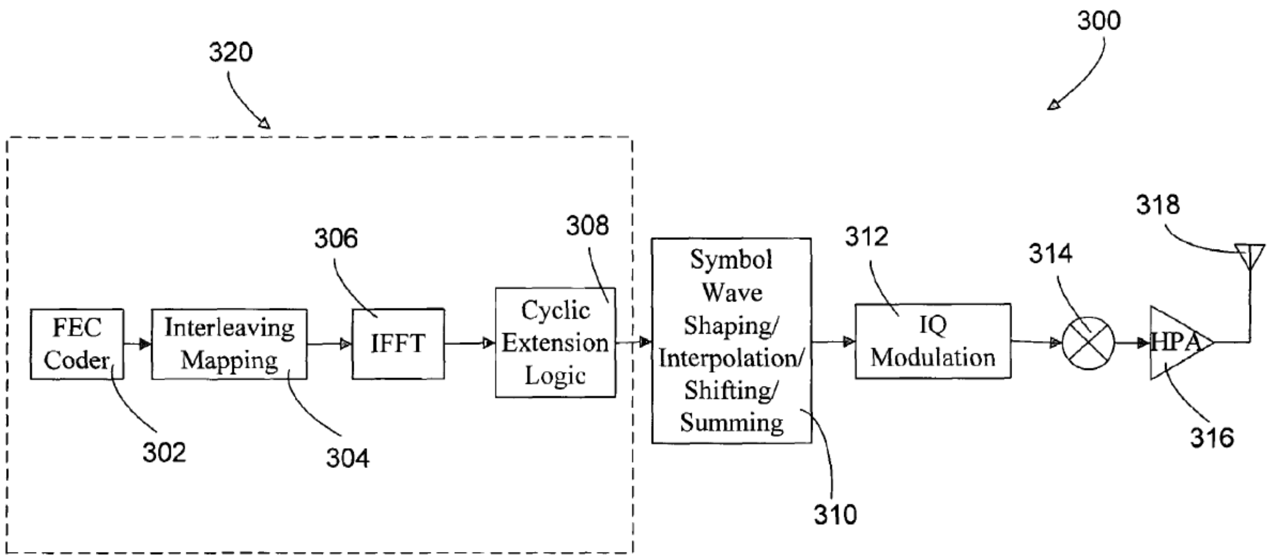
a first up-converted analog signal comprising a first up-converted frequency range from the first RF frequency minus one-half the first frequency range to the first RF frequency plus one-half the first frequency range;	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See*, *e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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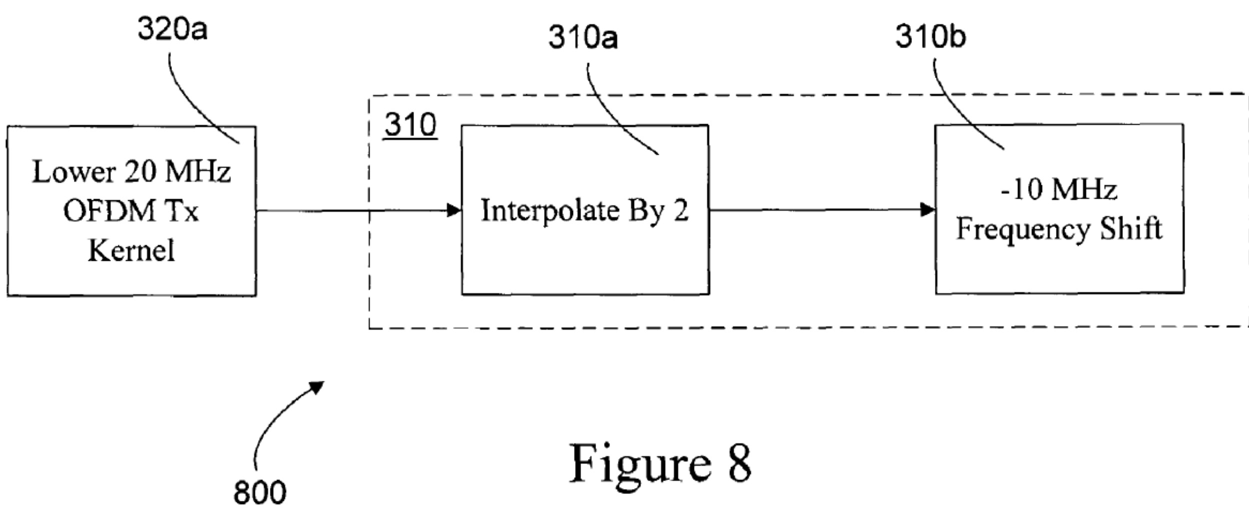
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

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	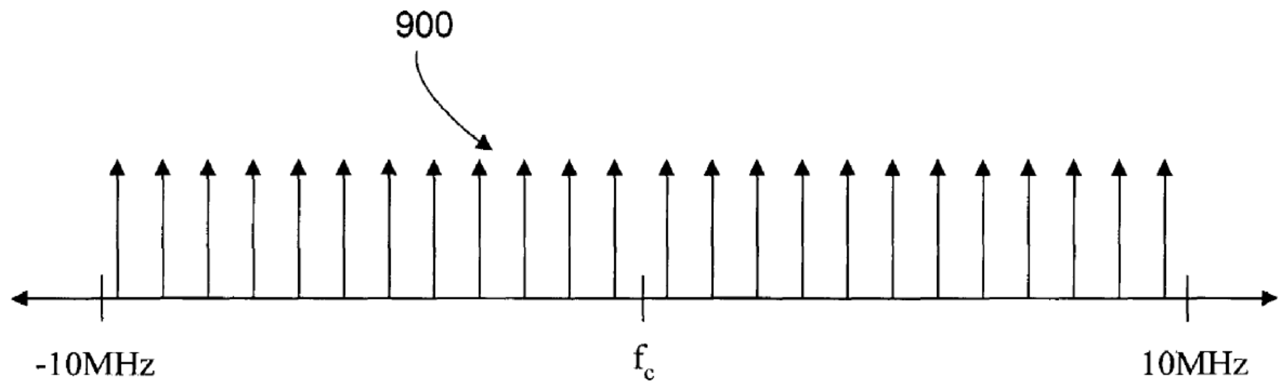 Figure 9 *See*, *e.g.*, Shearer at Figure 9.

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	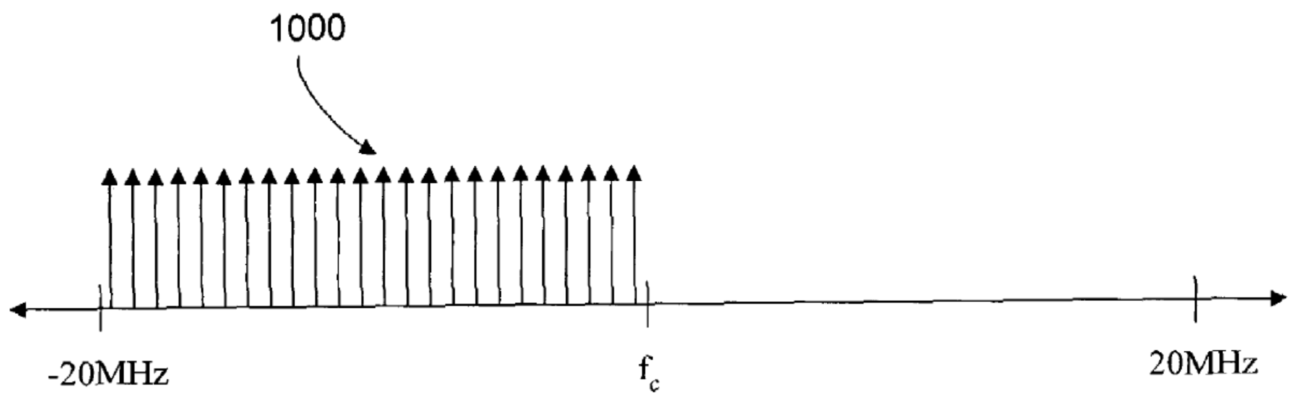 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

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	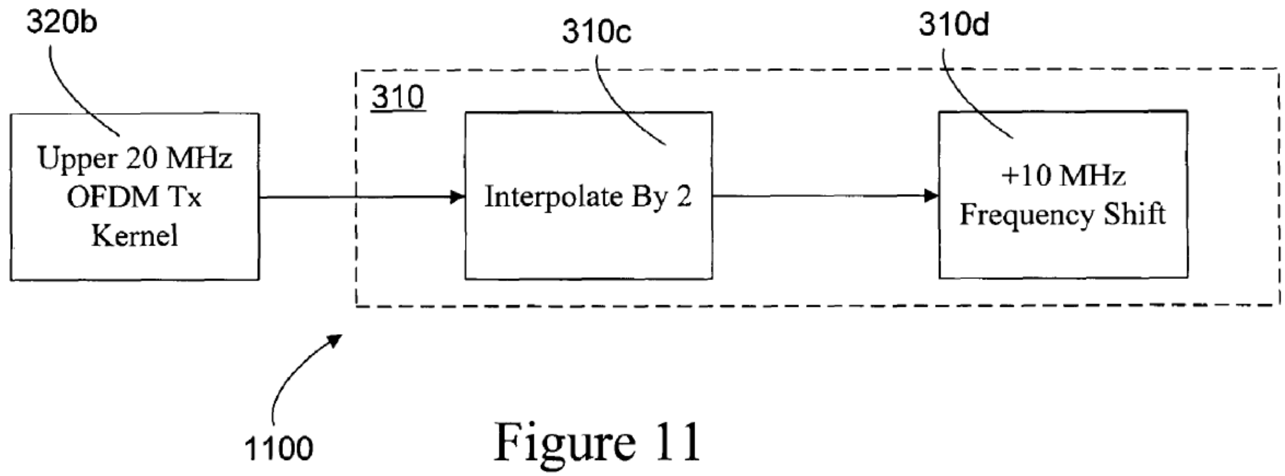 Figure 11 *See, e.g.*, Shearer at Figure 11.

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	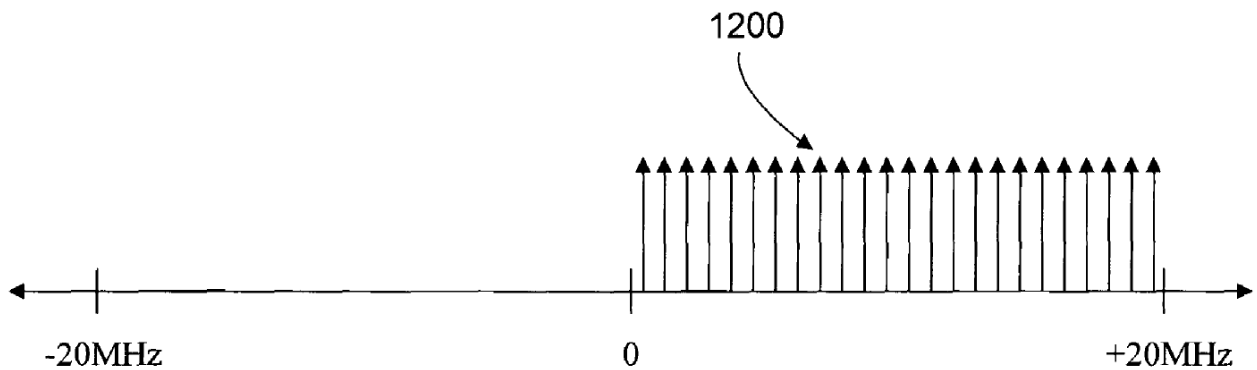 Figure 12 *See, e.g.*, Shearer at Figure 12.

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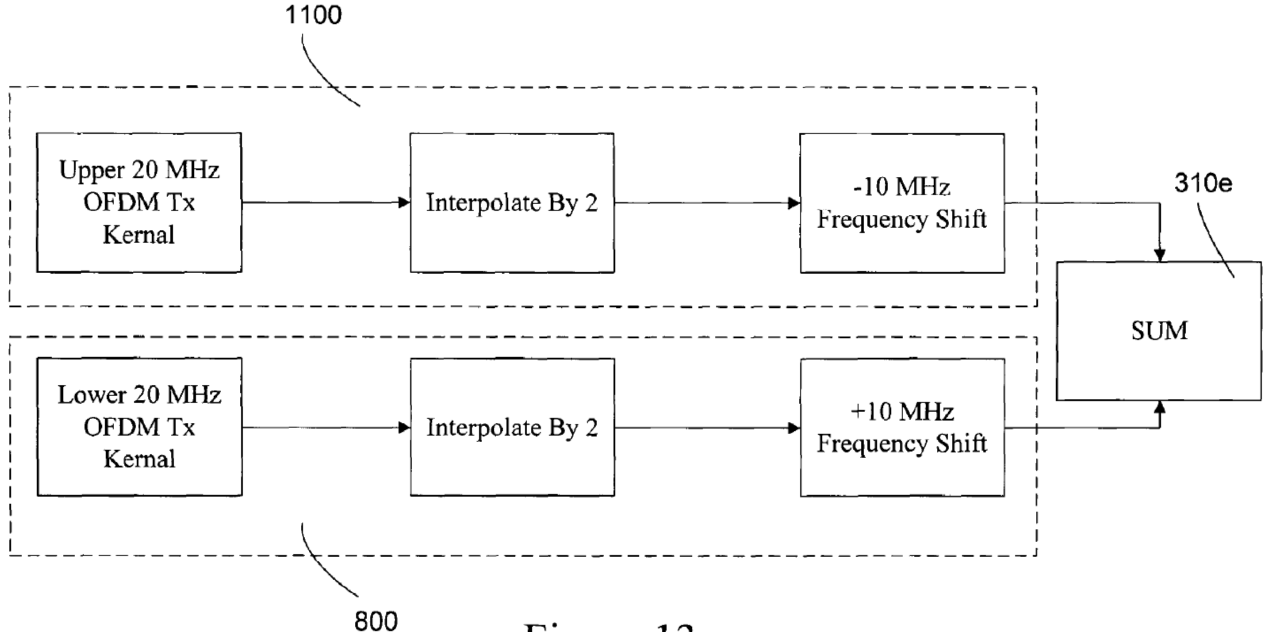
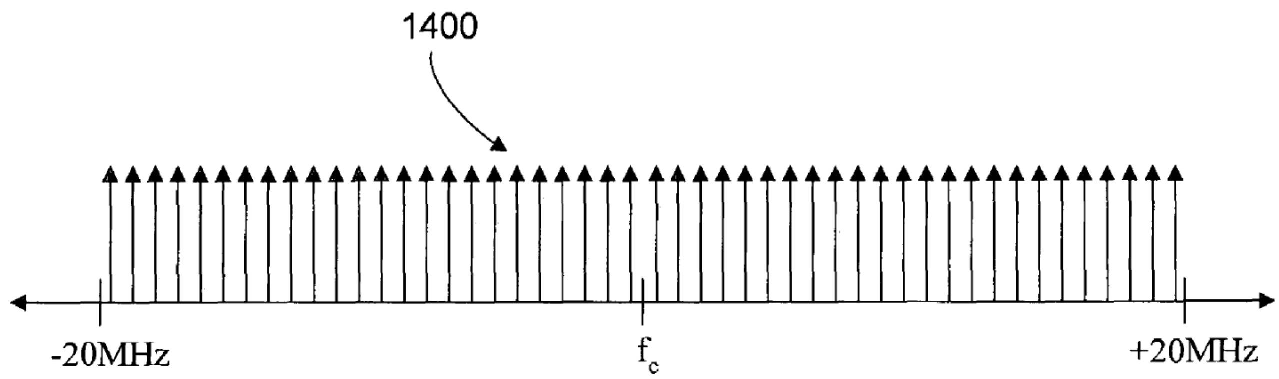
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

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	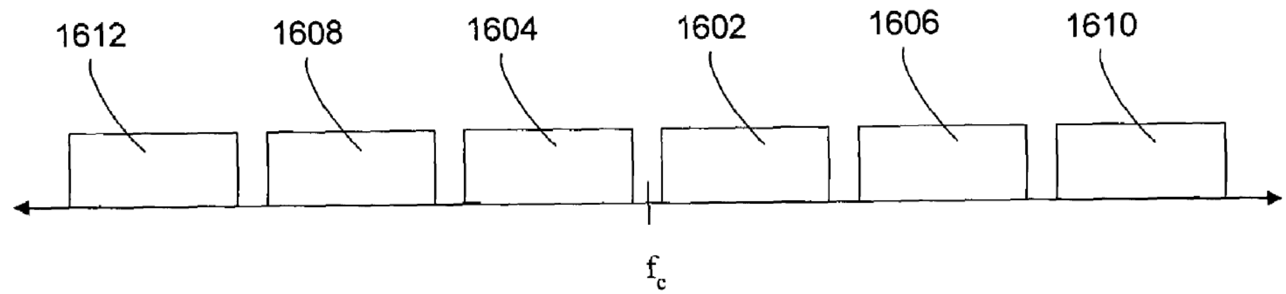 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.6] a second up-converter circuit having a first input coupled to receive the second analog signal and a second input coupled to receive a second modulation signal having a second RF frequency, wherein the second	Shearer discloses “a second up-converter circuit having a first input coupled to receive the second analog signal and a second input coupled to receive a second modulation signal having a second RF frequency, wherein the second up-converter outputs a second up-converted analog signal comprising a second up-converted frequency range from the second RF frequency minus one-half the second frequency range to the second RF frequency plus one-half the second frequency range, and wherein frequency difference between the first RF frequency and the second RF frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range.” See, e.g.:

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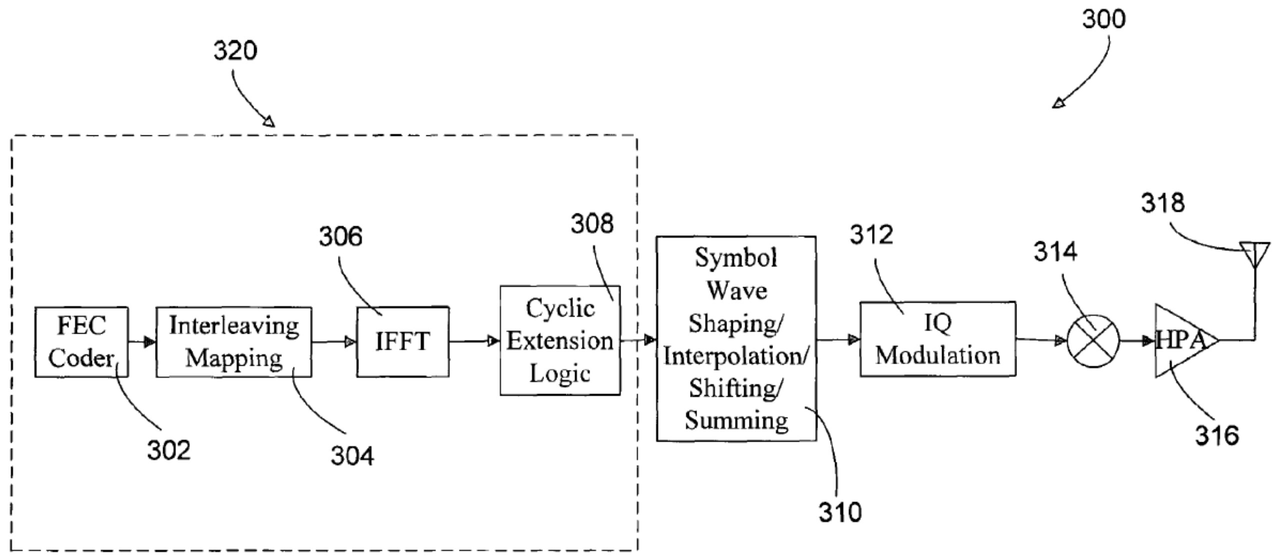
up-converter outputs a second up-converted analog signal comprising a second up-converted frequency range from the second RF frequency minus one-half the second frequency range to the second RF frequency plus one-half the second frequency range, and wherein frequency difference between the first RF frequency and the second RF frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range; and	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of

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	the terminals are capable of communicating with at least two of the access points when located within a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308.

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	During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC) code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz

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	channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A

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	lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are

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	received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for

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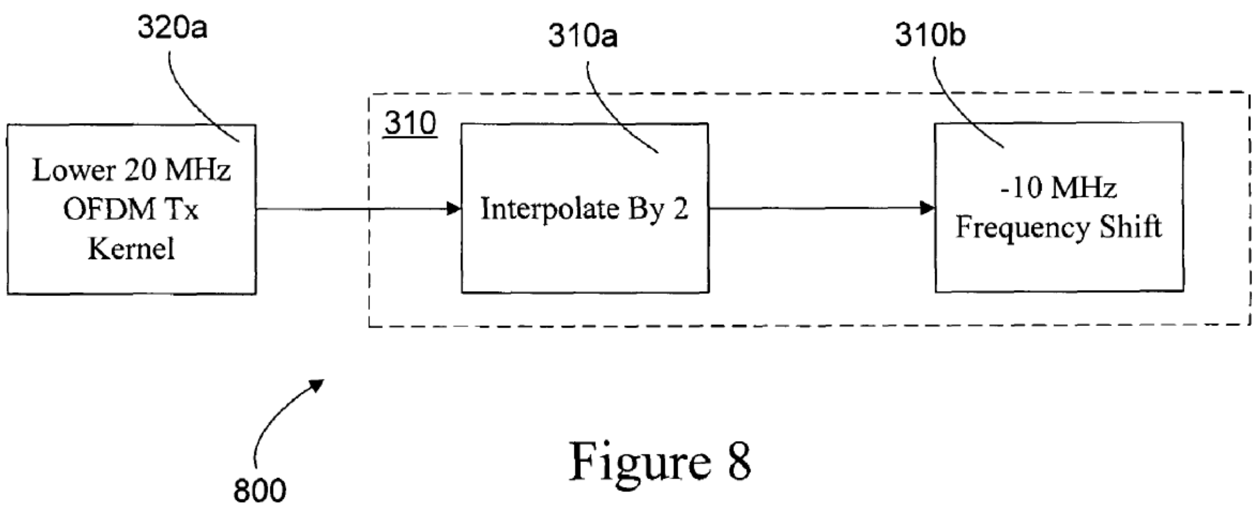
	transmission. This process is applicable for any even number of input signals. Each simultaneous input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

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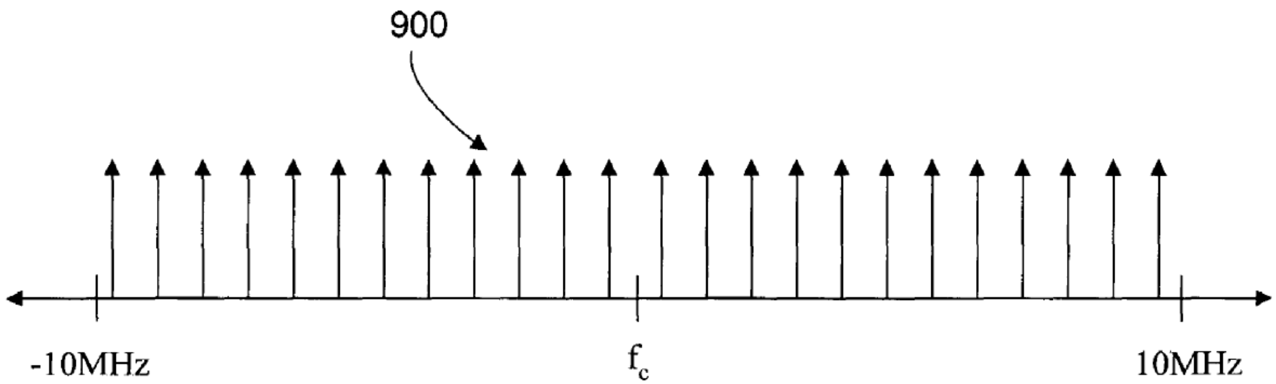
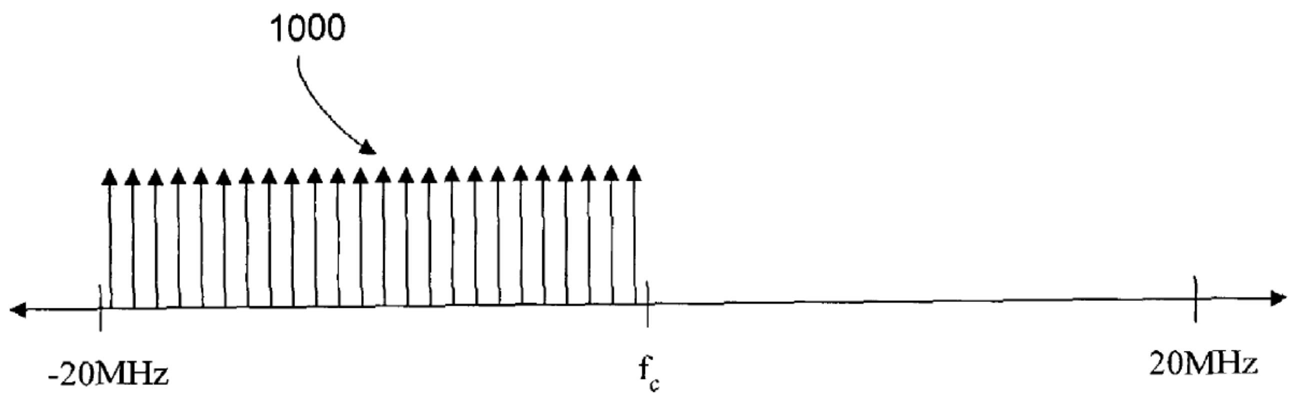
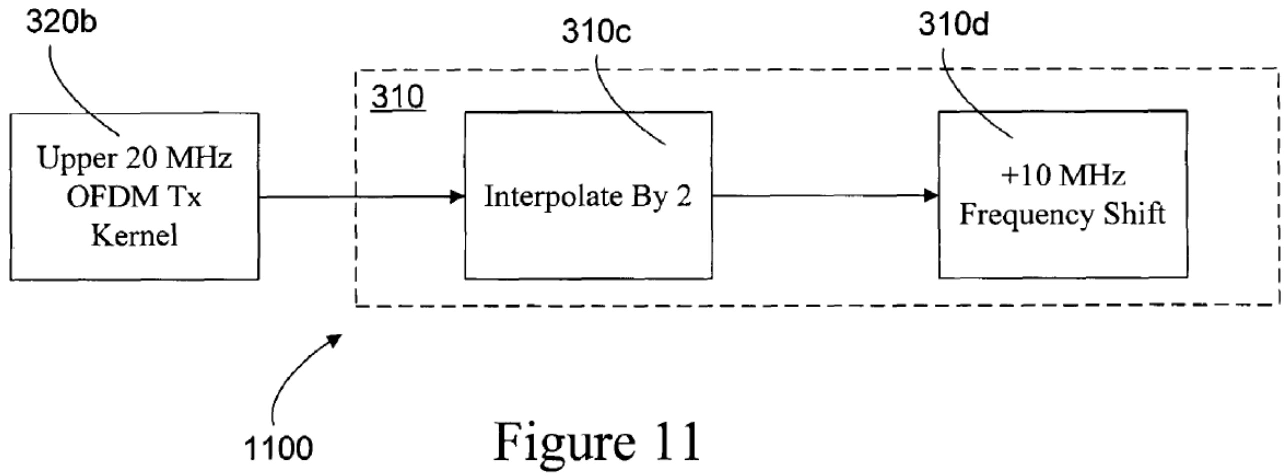
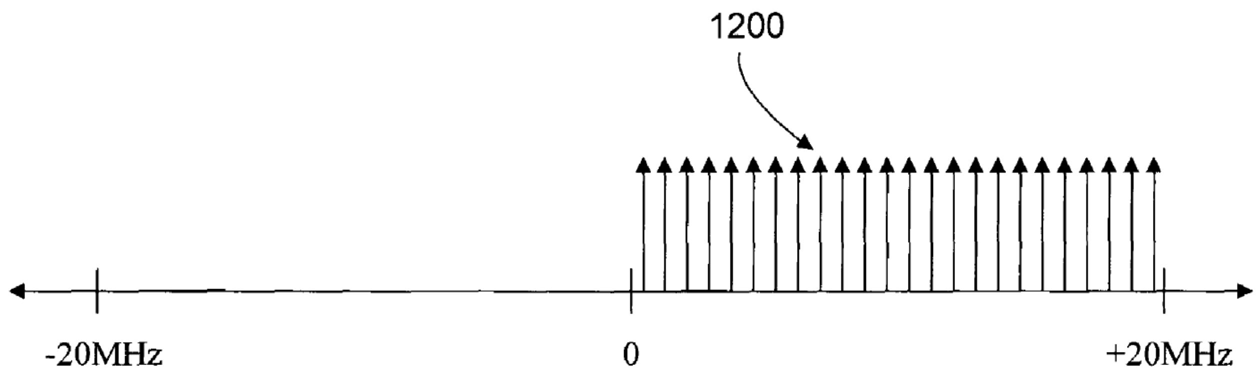
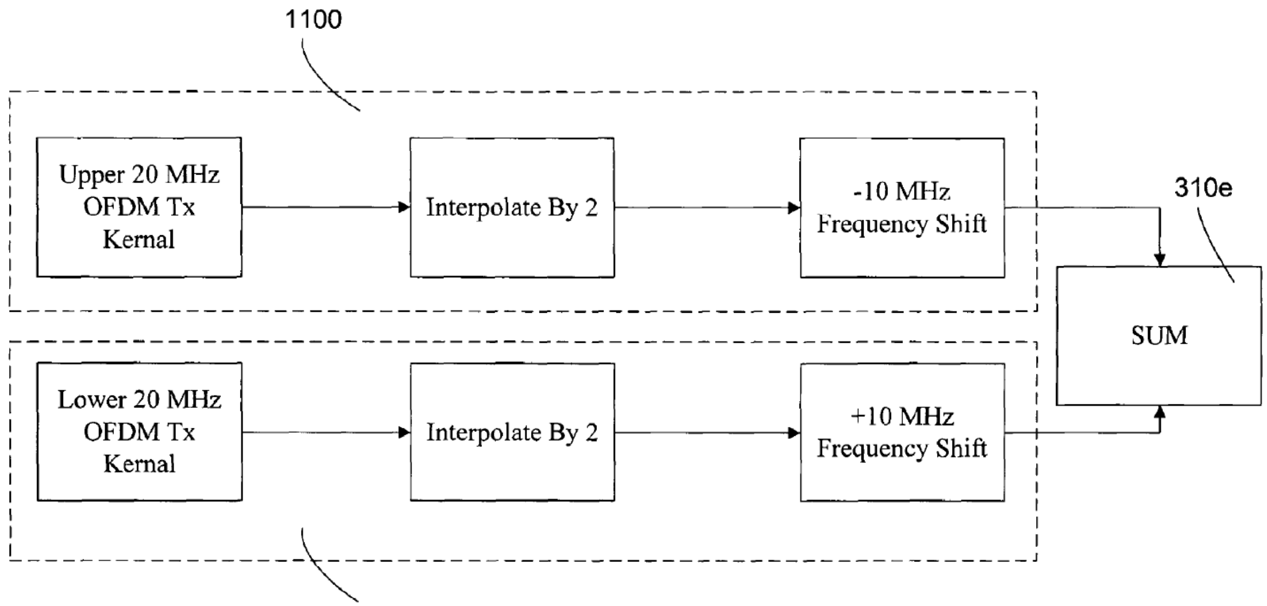
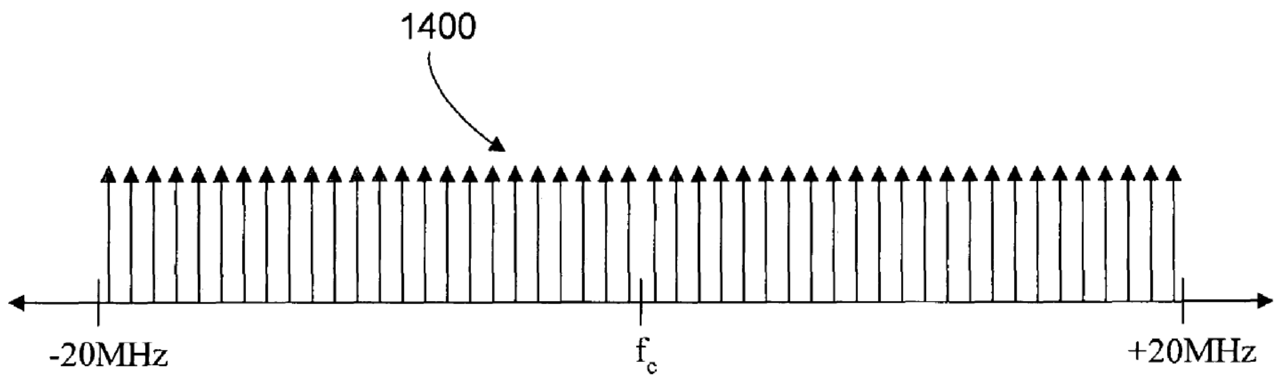
	 Figure 9 *See, e.g.*, Shearer at Figure 9.

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 10 *See, e.g.*, Shearer at Figure 10.

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 17 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 17 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

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	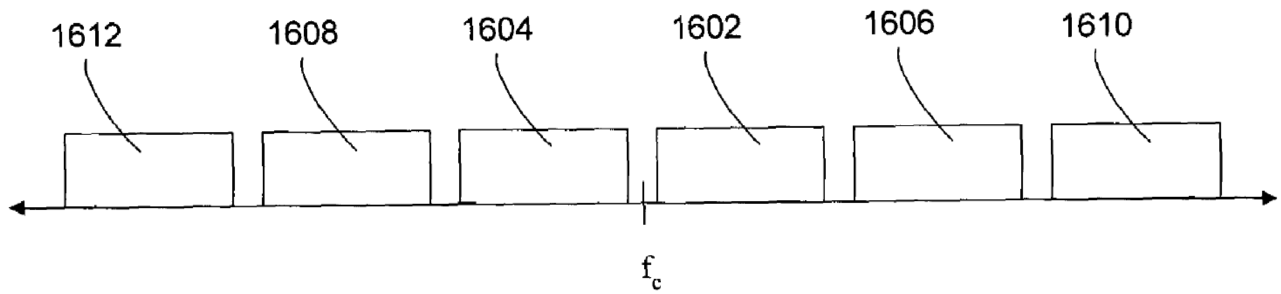 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.7] a power amplifier coupled to receive the first and second up-converted analog signals, wherein the bandwidth of the power amplifier is greater than the difference between a lowest frequency in the first up-	Shearer discloses "a power amplifier coupled to receive the first and second up-converted analog signals, wherein the bandwidth of the power amplifier is greater than the difference between a lowest frequency in the first up-converted frequency range and a highest frequency in the second up-converted frequency range." See, e.g.:

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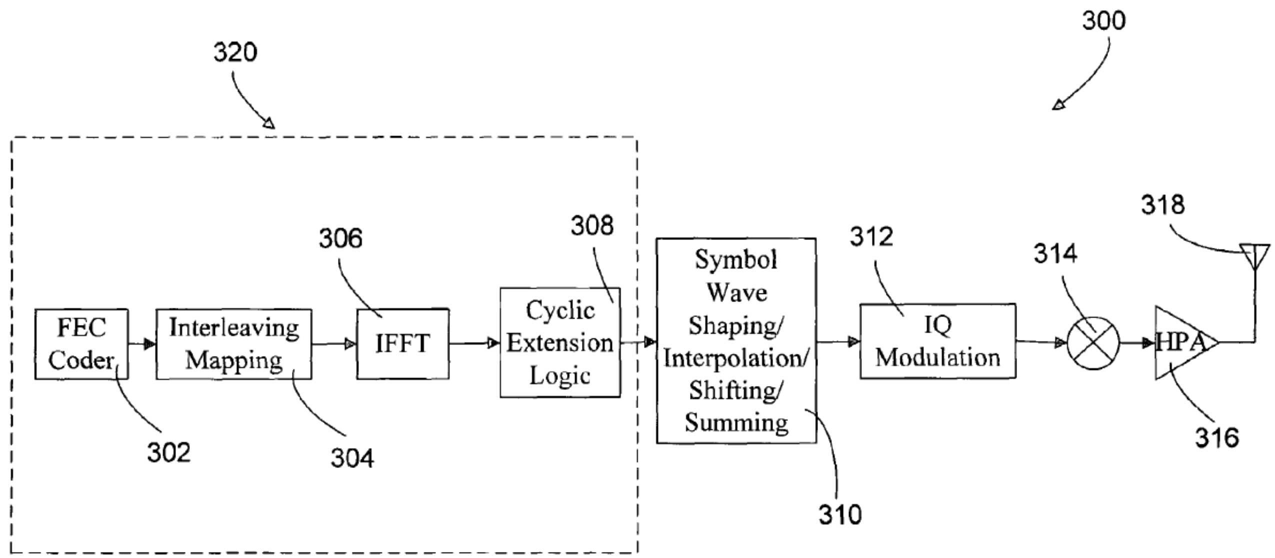
converted frequency range and a highest frequency in the second up-converted frequency range.	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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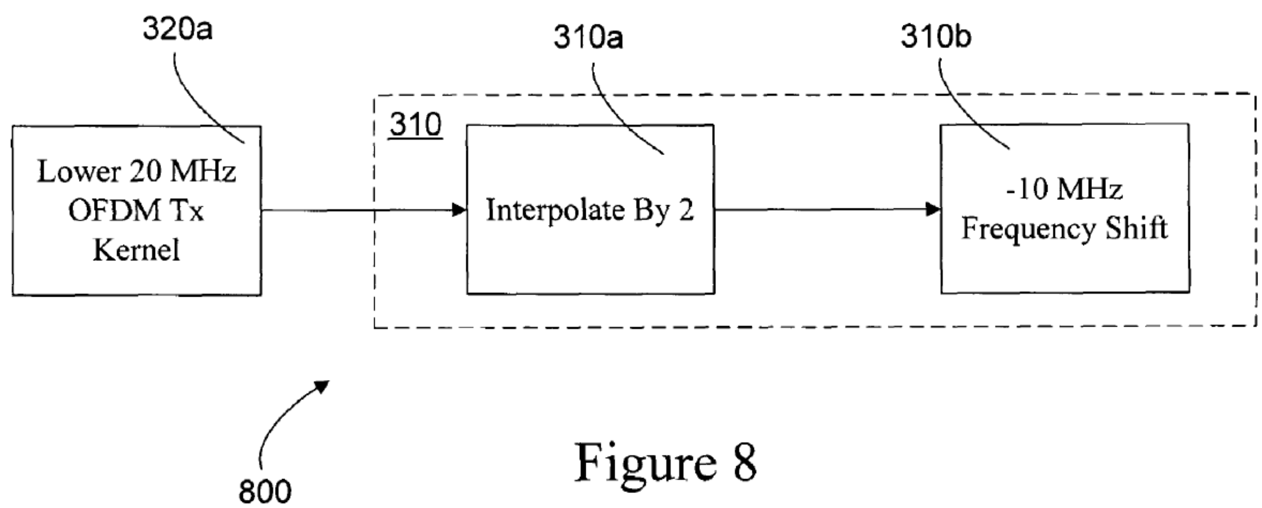
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  *See, e.g.*, Shearer at Figure 8.

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	Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 21 of the ’802 Patent	**Prior Art Reference – Shearer**
[21.1] The communication system of claim 17	Shearer discloses all the elements of claim 17 for all the reasons provided above.
[21.2] wherein the first data of the first digital signal is encoded using a first wireless protocol and the first data of the second digital signal is encoded using a second wireless protocol.	Shearer discloses “wherein the first data of the first digital signal is encoded using a first wireless protocol and the first data of the second digital signal is encoded using a second wireless protocol.” See, e.g.:

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	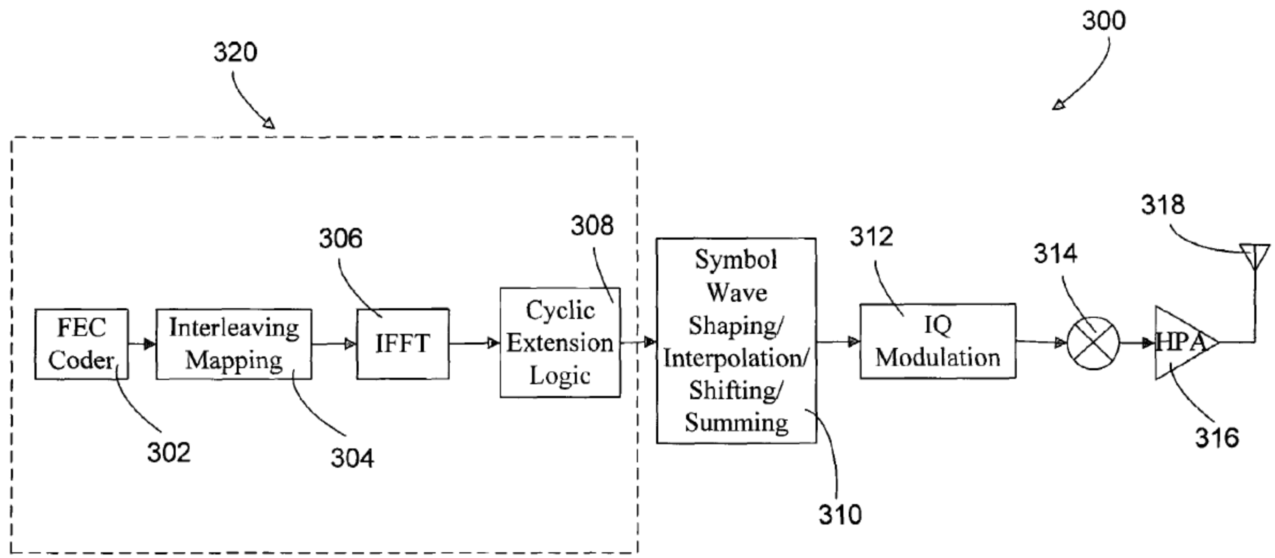 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See*, *e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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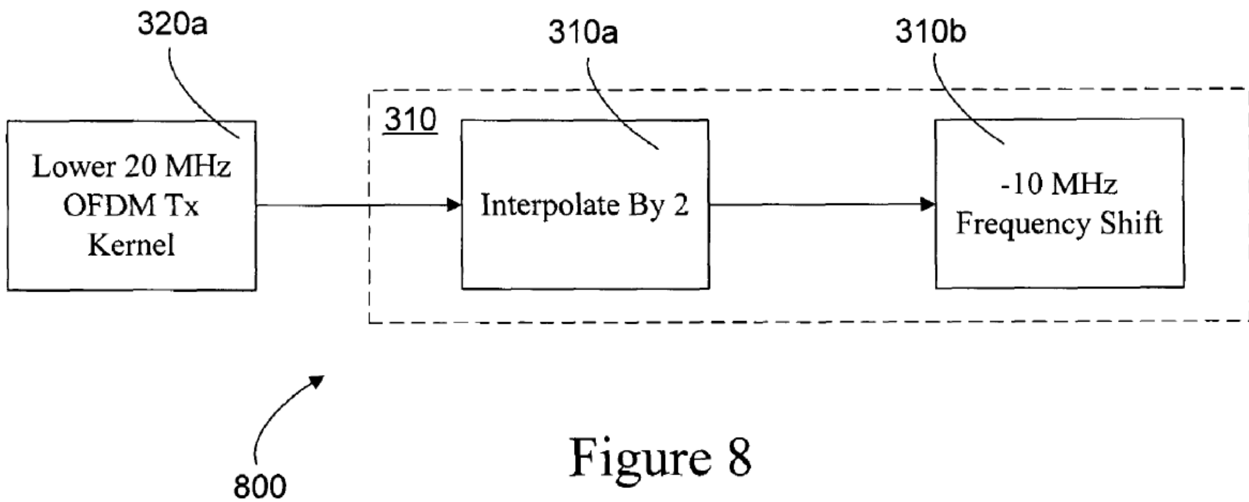
	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54.  Figure 8 *See, e.g.*, Shearer at Figure 8.

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	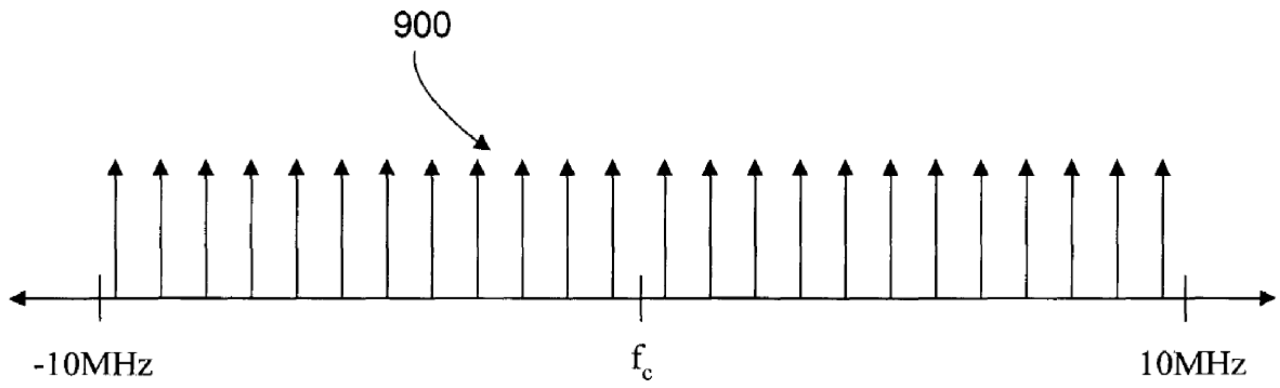 Figure 9 *See, e.g.*, Shearer at Figure 9.

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	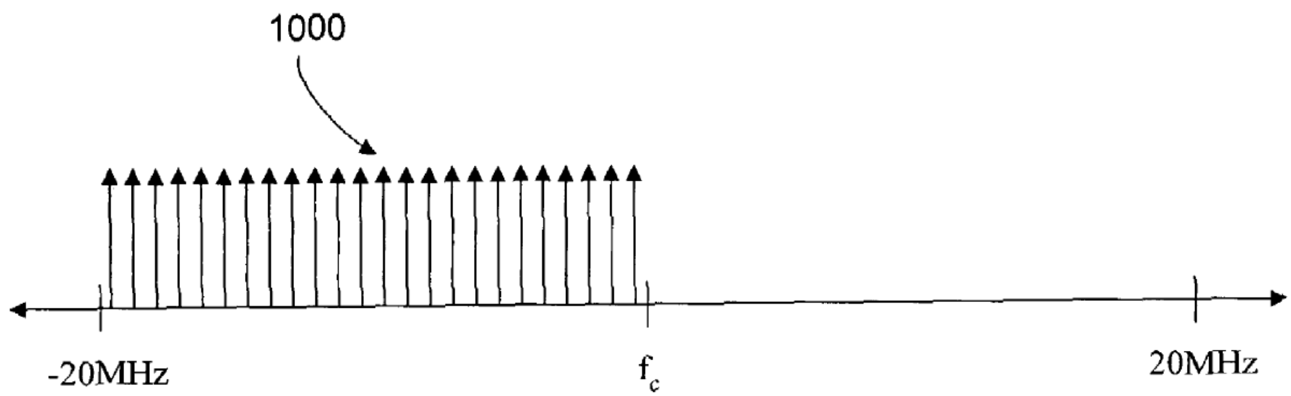 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

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	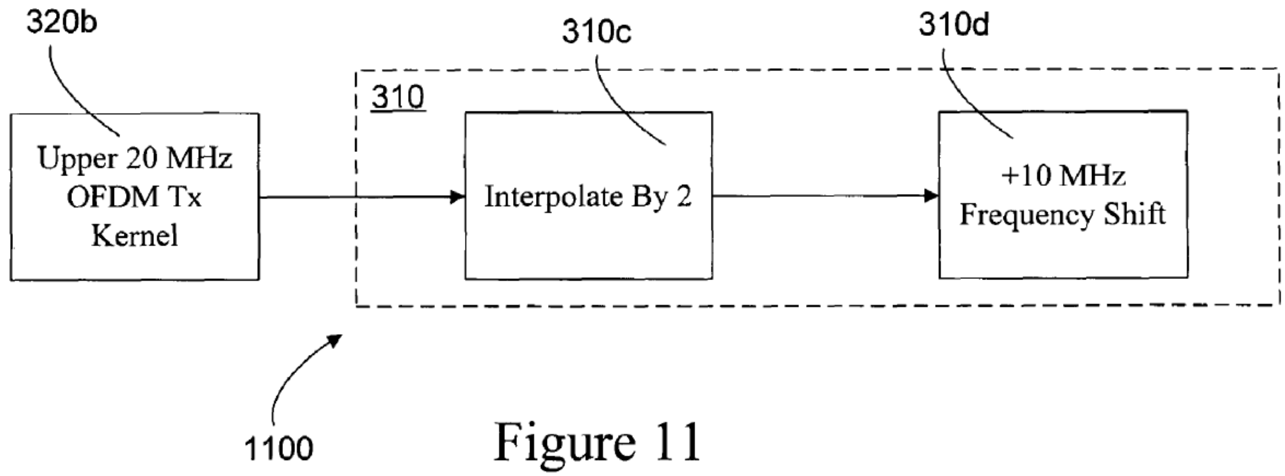 Figure 11 *See, e.g.*, Shearer at Figure 11.

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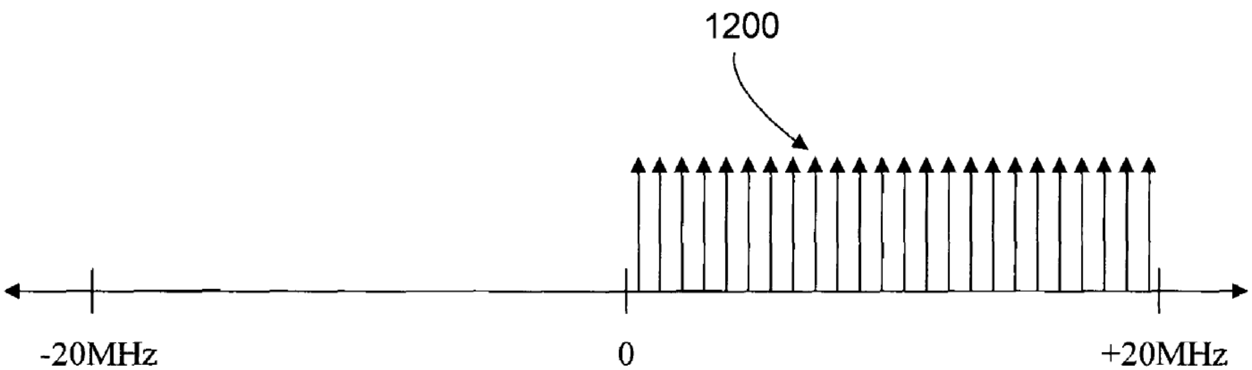
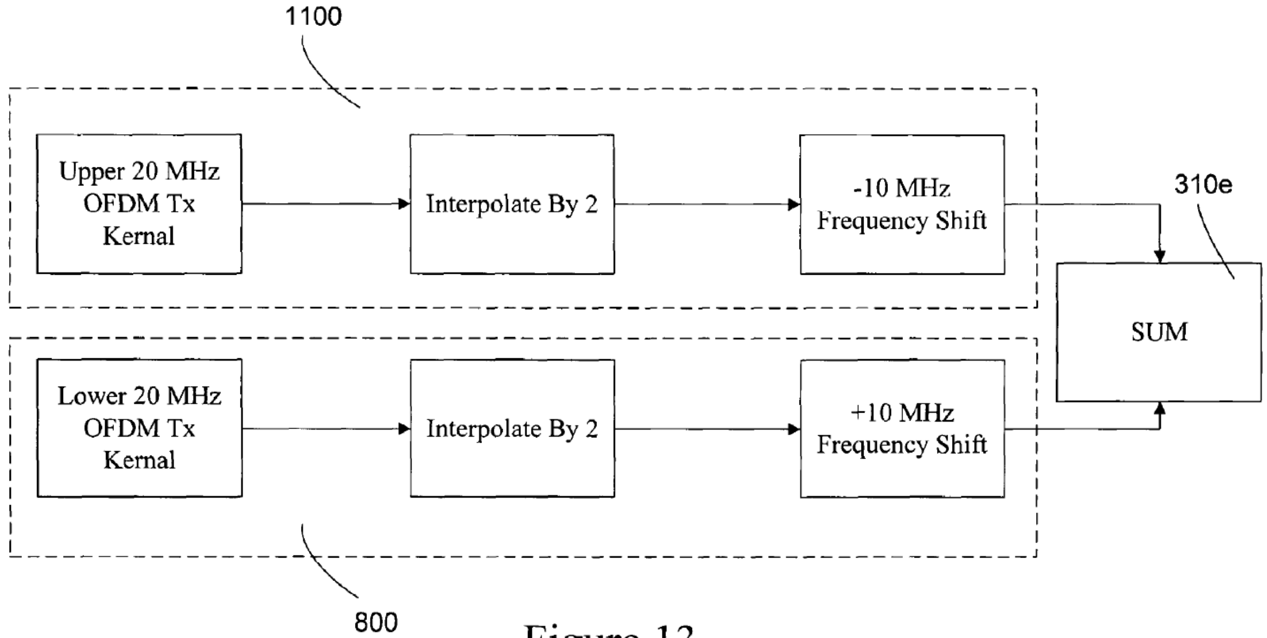
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 21 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

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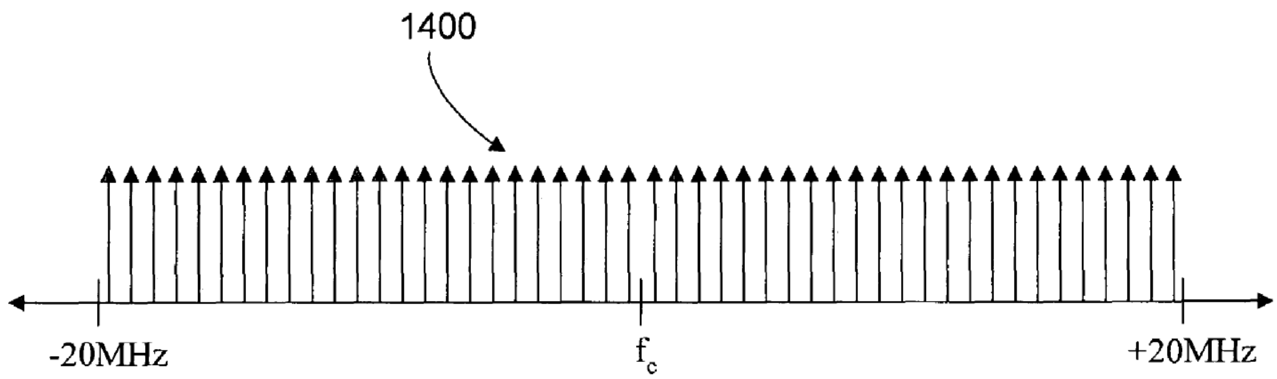
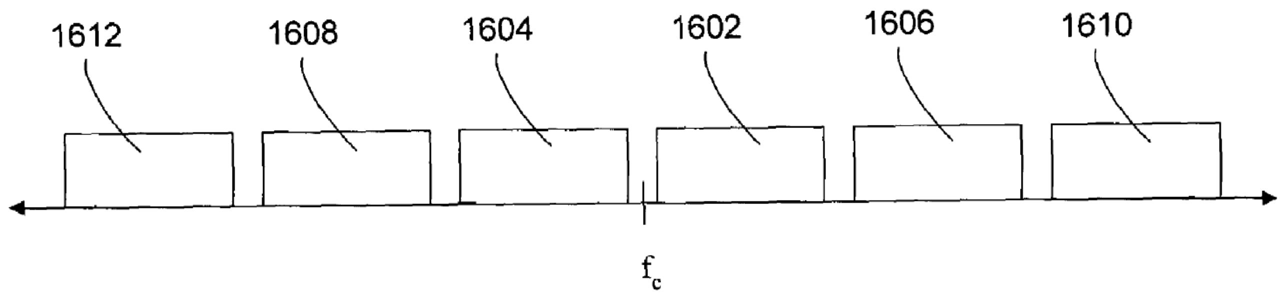
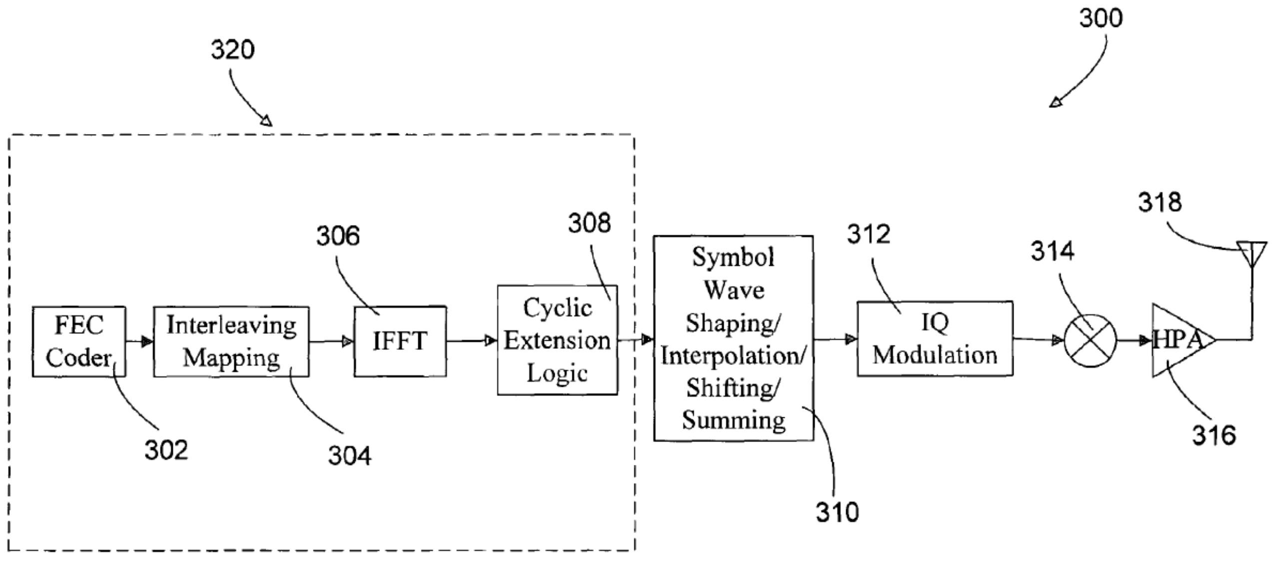
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 21 of the '802 Patent	**Prior Art Reference – Shearer**
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 22 of the '802 Patent	**Prior Art Reference – Shearer**
[22.1] The communication system of claim 17	Shearer discloses all the elements of claim 17 for all the reasons provided above.
[22.2] wherein the second data corresponds to the first data and wherein the power	Shearer discloses "wherein the second data corresponds to the first data and wherein the power amplifier outputs a third up-converted signal comprising the up-converted first analog signal and the up-converted second analog signal." See, e.g.:

Claim 22 of the '802 Patent	Prior Art Reference – Shearer
amplifier outputs a third up-converted signal comprising the up-converted first analog signal and the up-converted second analog signal.	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host

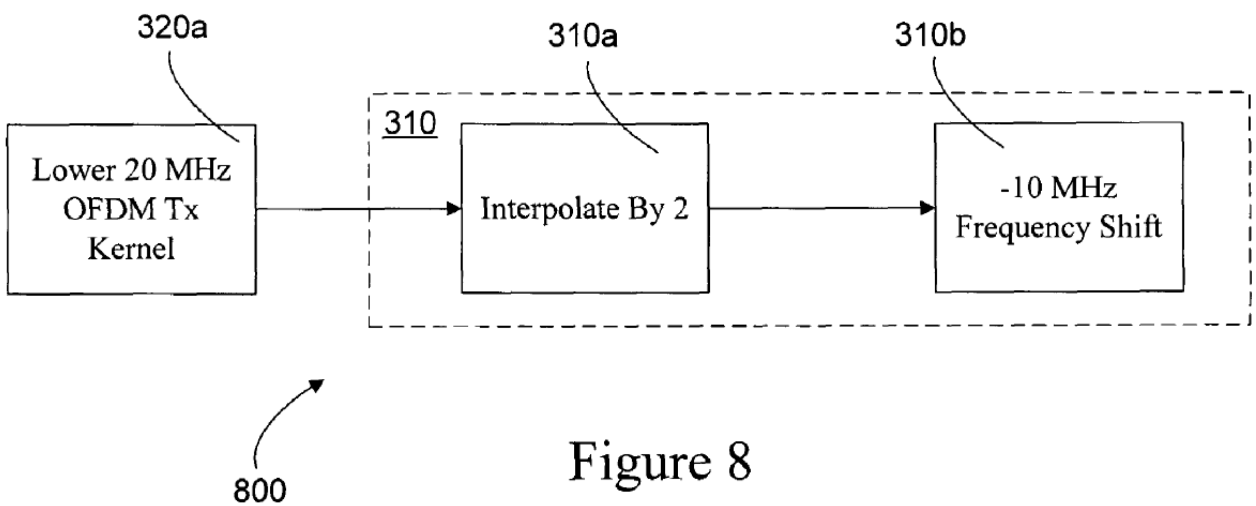
Claim 22 of the ’802 Patent	Prior Art Reference – Shearer
	computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308.

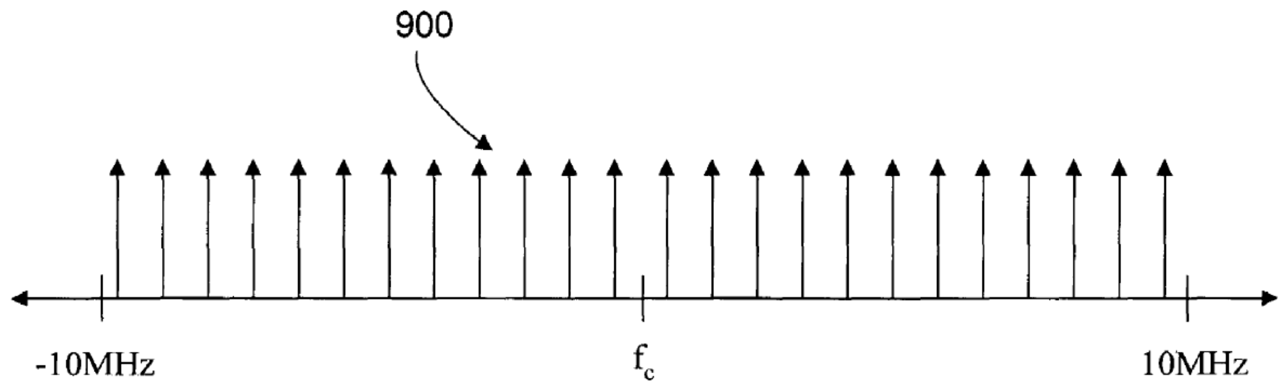
Claim 22 of the '802 Patent	Prior Art Reference – Shearer
	During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC) code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz

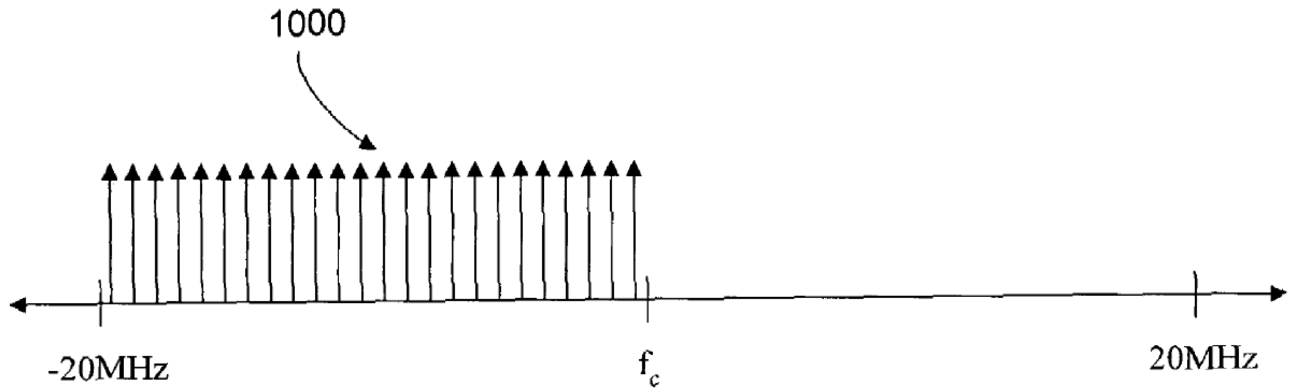
Claim 22 of the '802 Patent	Prior Art Reference – Shearer
	channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A

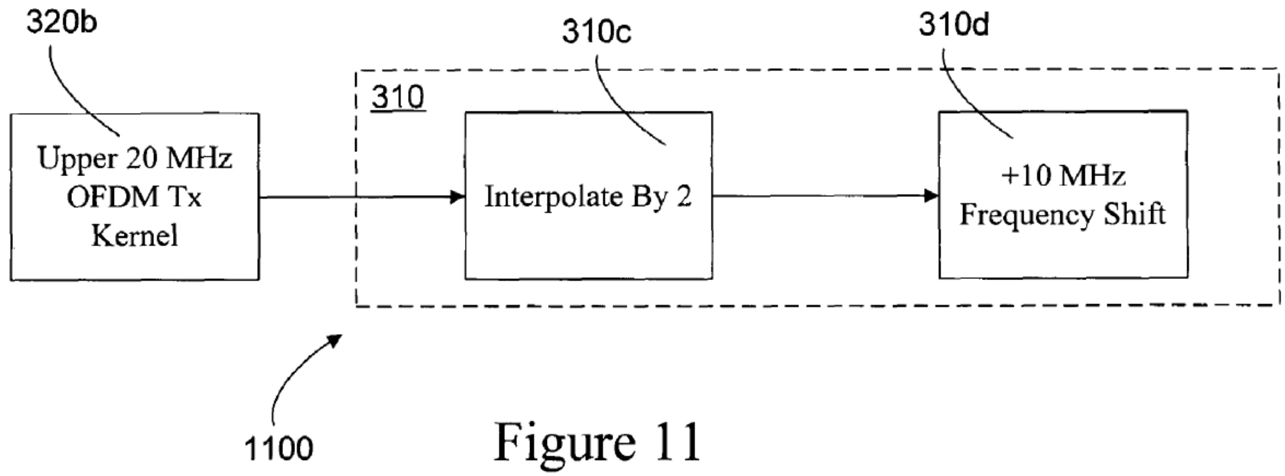
Claim 22 of the '802 Patent	Prior Art Reference – Shearer
	lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shif ter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are

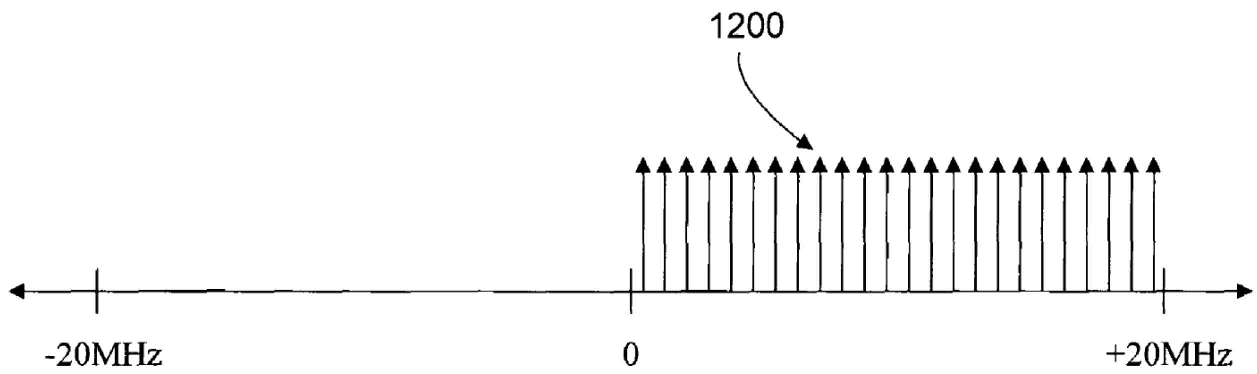
Claim 22 of the ’802 Patent	Prior Art Reference – Shearer
	received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for

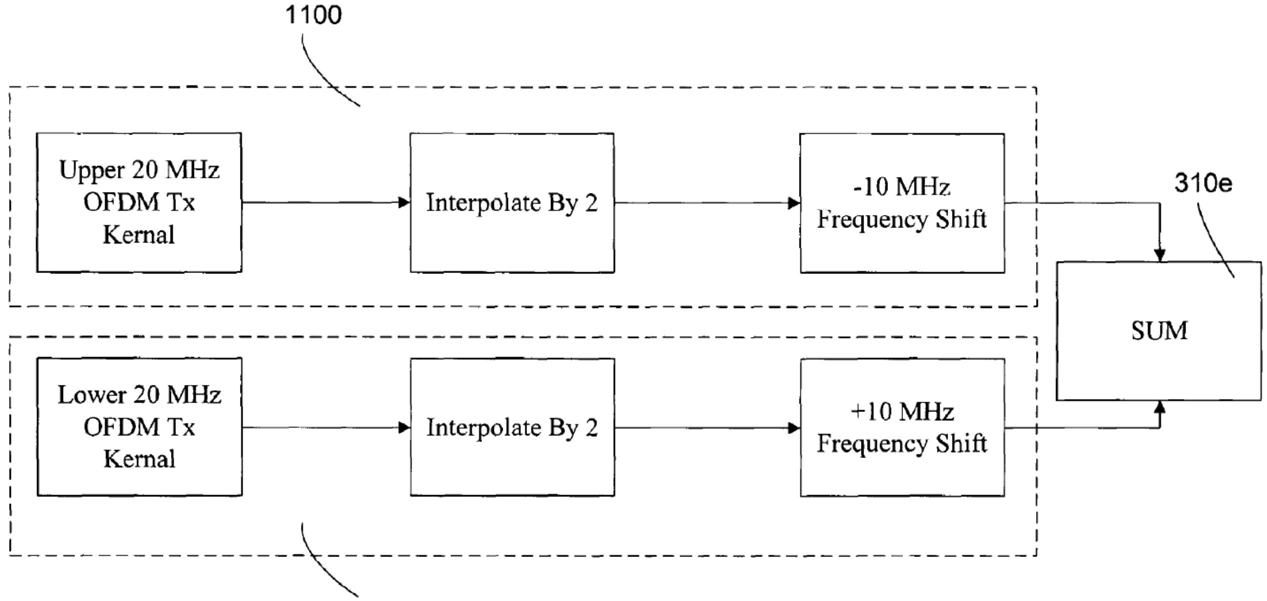
Claim 22 of the '802 Patent	Prior Art Reference – Shearer
	transmission. This process is applicable for any even number of input signals. Each simultaneous input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See*, *e.g.*, Shearer at 9:25-54.  Figure 8 *See*, *e.g.*, Shearer at Figure 8.

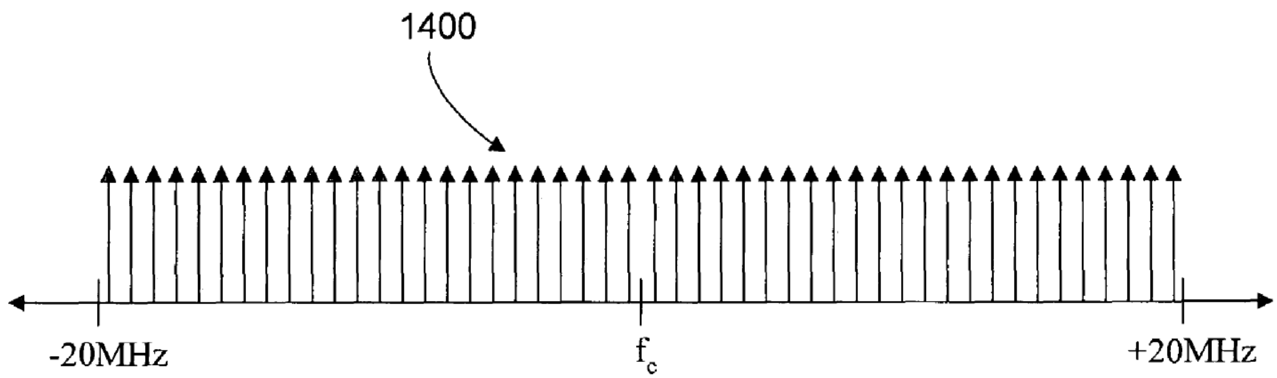
Claim 22 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 9 *See*, *e.g.*, Shearer at Figure 9.

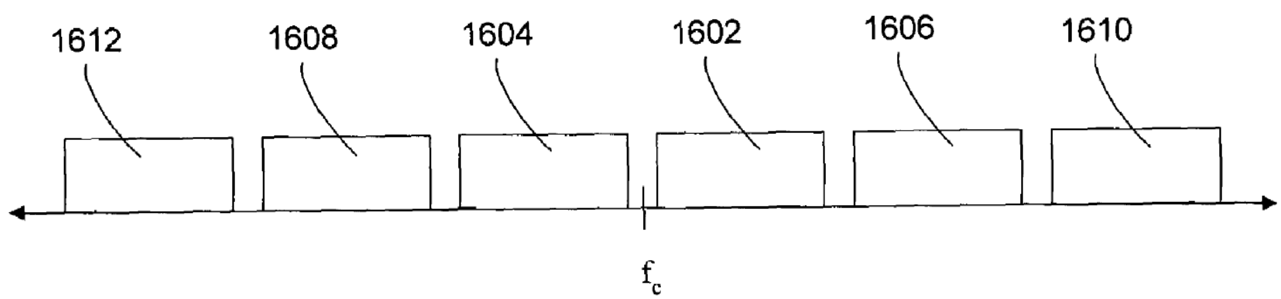
Claim 22 of the '802 Patent	**Prior Art Reference – Shearer**
	 Figure 10 *See*, *e.g.*, Shearer at Figure 10.

Claim 22 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 11 *See, e.g.*, Shearer at Figure 11.

Claim 22 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 12 *See, e.g.*, Shearer at Figure 12.

Claim 22 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 13 *See*, *e.g.*, Shearer at Figure 13.

Claim 22 of the ’802 Patent	Prior Art Reference – Shearer
	 Figure 14 *See, e.g.*, Shearer at Figure 14.

Claim 22 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 16 *See, e.g.*, Shearer at Figure 16. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

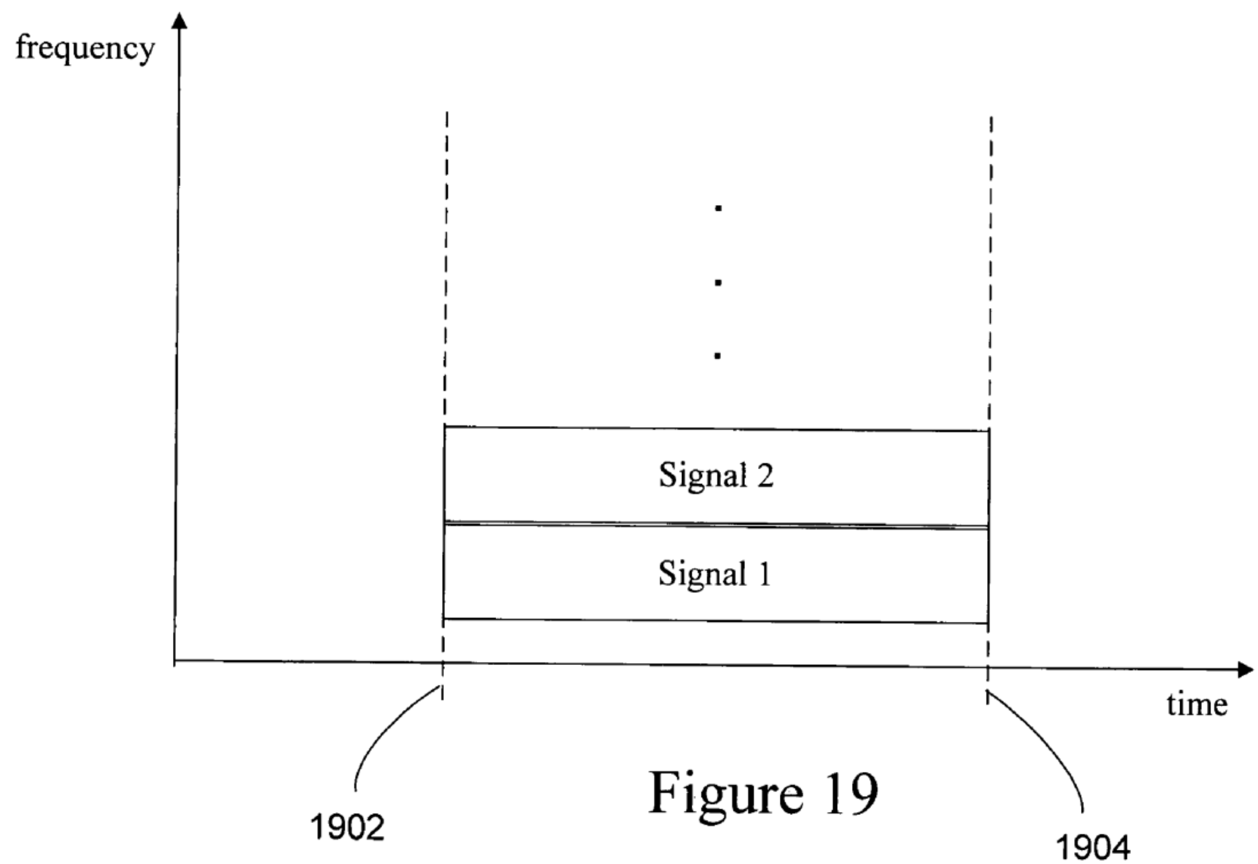
Claim 23 of the '802 Patent	Prior Art Reference – Shearer
[23.1] The communication system of claim 17	Shearer discloses all the elements of claim 17 for all the reasons provided above.
[23.2] wherein first and second data to be transmitted comprise a plurality of OFDM	Shearer discloses "wherein first and second data to be transmitted comprise a plurality of OFDM symbols, wherein a first symbol is transmitted during a first time slot across the first up-converted frequency range and a second symbol is transmitted during the first time slot across the second up-

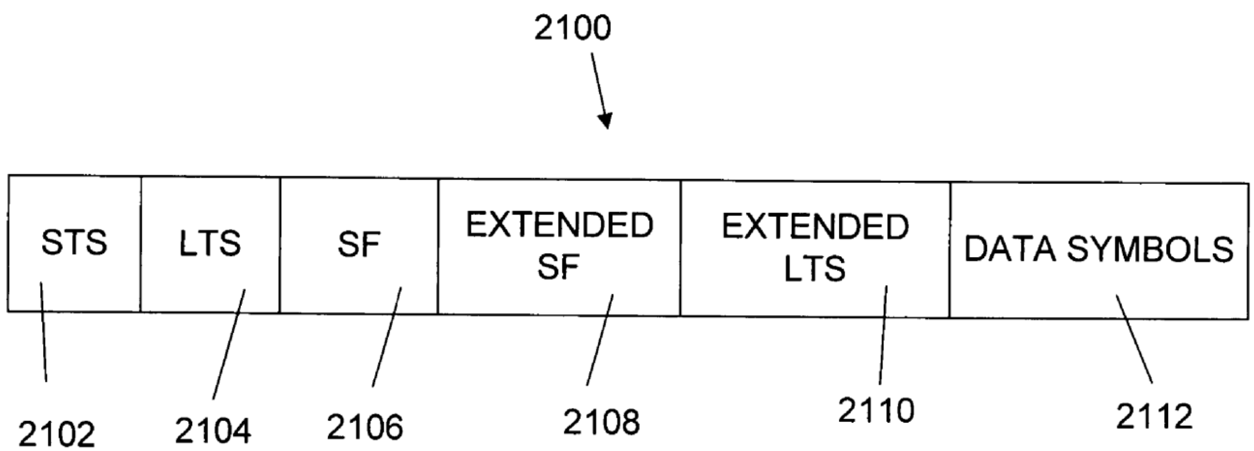
Claim 23 of the ’802 Patent	Prior Art Reference – Shearer
symbols, wherein a first symbol is transmitted during a first time slot across the first up-converted frequency range and a second symbol is transmitted during the first time slot across the second up-converted frequency range, and wherein a third symbol is transmitted during a second time slot across the first up-converted frequency range and a fourth symbol is transmitted during the second time slot across a second up-converted frequency range.	converted frequency range, and wherein a third symbol is transmitted during a second time slot across the first up-converted frequency range and a fourth symbol is transmitted during the second time slot across a second up-converted frequency range.” See, e.g.: The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the

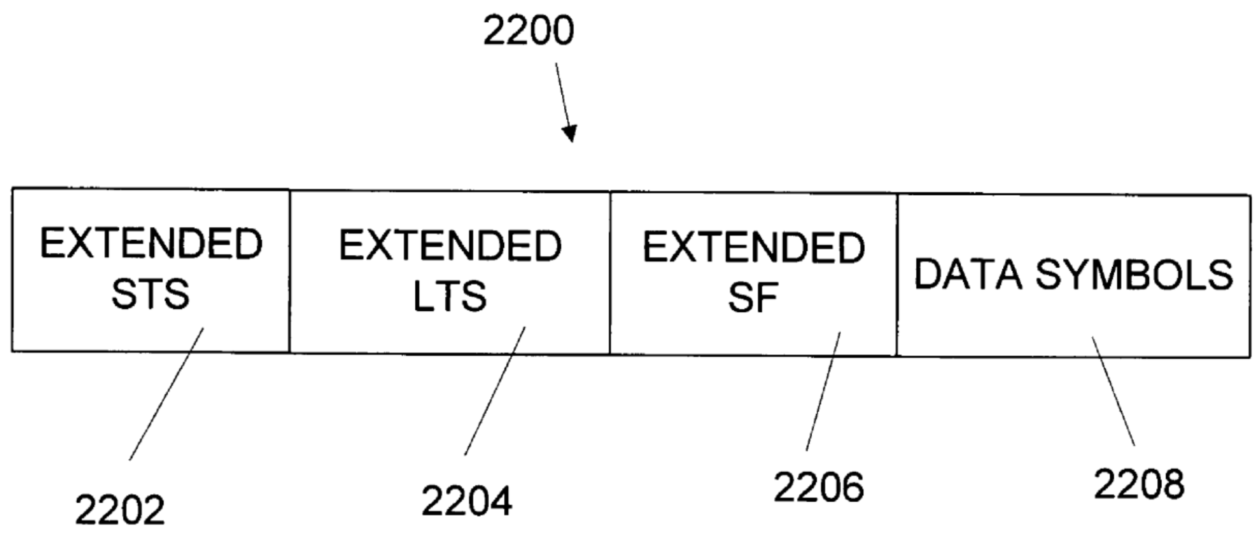
Claim 23 of the ’802 Patent	Prior Art Reference – Shearer
	packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2.

Claim 23 of the ’802 Patent	Prior Art Reference – Shearer
	The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12.

Claim 23 of the ’802 Patent	Prior Art Reference – Shearer
	FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. FIG. 19 is a graph of each signal and its frequency vs. time relationship. Each signal's start time 1902 and end time 1904 is preferably substantially equivalent to eliminate problems with multiple signal acquisition and termination. These problems may include transmitting and receiving simultaneously. By occupying “both” channels at the same time, simultaneous transmitting and receiving is enabled. *See, e.g.*, Shearer at 10:31-38. An exemplary embodiment can support two types of packets, for example, for both 20 MHz and 40 MHz. The subcarrier alignment and receive detection methods detailed above apply to many nonlimiting packet types. One type of packet, as provided in FIG. 21, is a mixed-mode packet, which has the spectrally aligned legacy preamble/ header 2102, 2104, 2106, the extended header 2108, 2110, and data symbols 2112. A mixed-mode packet can occur for both 20 MHz and 40 MHz packets. In this case, it is important for legacy radios to see a legacy preamble/header. As such, a mixed-mode packet can start with a legacy preamble/ header 2102, 2104, 2106 and then follow with additional extended header/ preamble signal 2108, 2110. With mixed mode, the legacy radio receives what looks like a legacy packet, so it remains dormant through the following extended part. This allows for reception of legacy packets by legacy radios without disruption by an extended packet. This is sometimes referred to as spoofing a legacy radio. As provided in FIG. 22, a second type of packet 2200 is called Greenfield, which can occur for both 20 MHz and 40 MHz packets. In this case, it is not necessary to have a legacy radio process the

Claim 23 of the '802 Patent	Prior Art Reference – Shearer
	packet. A Greenfield packet 2200 can be used in an environment (or time slot) where no legacy radios are receiving. As such, the packet begins immediately with an extended preamble/ header 2202, 2204, 2206, followed by data symbols 2208. *See, e.g.*, Shearer at 11:23-48.  Figure 19

Claim 23 of the '802 Patent	Prior Art Reference – Shearer
	See, e.g., Shearer at Figure 19.  Figure 21 *See, e.g.*, Shearer at Figure 21.

Claim 23 of the '802 Patent	Prior Art Reference – Shearer
	 Figure 22 *See, e.g.*, Shearer at Figure 22. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further

Claim 23 of the '802 Patent	Prior Art Reference – Shearer
	motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 24 of the '802 Patent	Prior Art Reference – Shearer
[24.1] An electronic circuit comprising:	To the extent the preamble is limiting, Shearer discloses "An electronic circuit comprising." See, e.g.: Disclosed herein are various embodiments of methods, systems, and apparatus for increasing packet generation in a digital communication system. In one exemplary method embodiment, subcarriers are added to a packet in a wireless local area network transmission to increase the data rate. *See, e.g.*, Shearer at Abstract. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. *See, e.g.*, Shearer at 1:31-38. 802.11 is directed to wireless LANs, and in particular specifies the MAC and the PHY layers. These layers are intended to correspond closely to the two lowest layers of a system based on the ISO Basic Reference Model of OSI, i.e., the data link layer and the physical layer. FIG. 1 shows a diagrammatic representation of an open systems interconnection (OSI) layered model 100 developed by the International Organization for Standards (ISO) for describing the exchange of information between layers in communication networks. The OSI layered model 100 is particularly useful for separating the technological functions of each layer, and thereby facilitating the modification or update of a given layer without detrimentally impacting on the functions of neighboring layers.

Claim 24 of the '802 Patent	Prior Art Reference – Shearer
	See, e.g., Shearer at 3:61-4:7. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. *See, e.g.*, Shearer at 4:62-5:4. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[24.2] a first down-converter circuit having a first input coupled to receive a first up-converted signal, a second input coupled to receive a first demodulation signal having a first RF frequency, and an output, wherein the first down-converter circuit outputs a first down-converted	Shearer discloses "a first down-converter circuit having a first input coupled to receive a first up-converted signal, a second input coupled to receive a first demodulation signal having a first RF frequency, and an output, wherein the first down-converter circuit outputs a first down-converted signal on the first down-converter output." See, e.g.:

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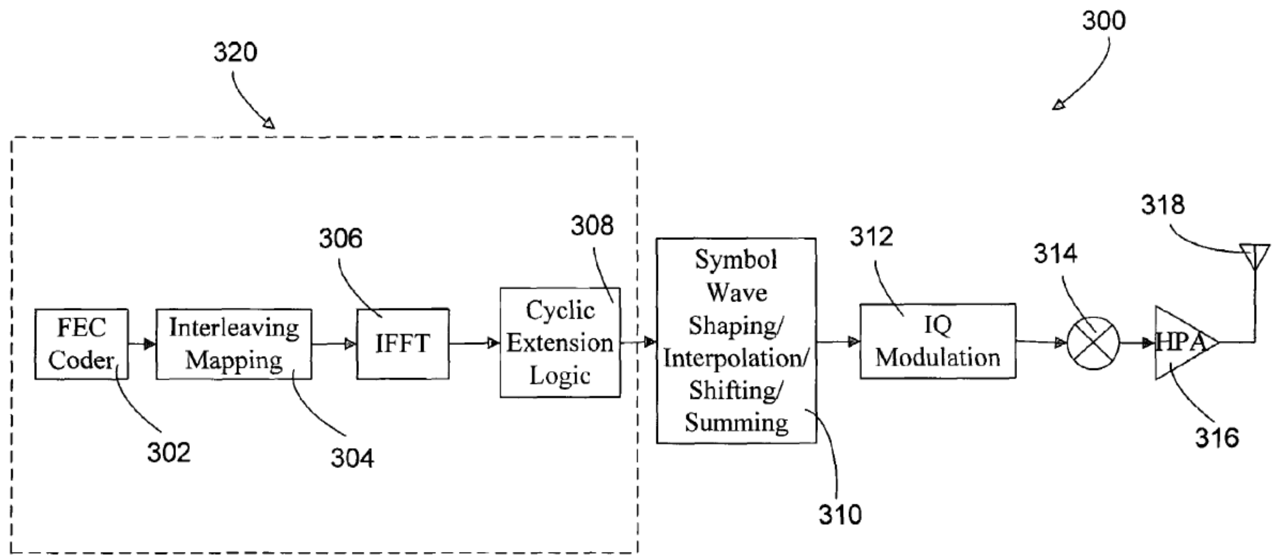
signal on the first down-converter output;	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

Claim 24 of the '802 Patent	Prior Art Reference – Shearer
	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 ("802.11") is set out in "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications" and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate "dead spots," and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[24.3] a second down-converter circuit having a first input coupled to receive the first up-converted signal, a second input coupled to receive a second demodulation signal having a second RF frequency different than the first RF frequency, and an output, wherein the second down-converter outputs a second down-converted signal on the second down-converter	Shearer discloses “a second down-converter circuit having a first input coupled to receive the first up-converted signal, a second input coupled to receive a second demodulation signal having a second RF frequency different than the first RF frequency, and an output, wherein the second down-converter outputs a second down-converted signal on the second down-converter output, wherein the first up-converted signal comprises a first signal modulated at the first RF frequency and a second signal modulated at the second RF frequency.” See, e.g.:

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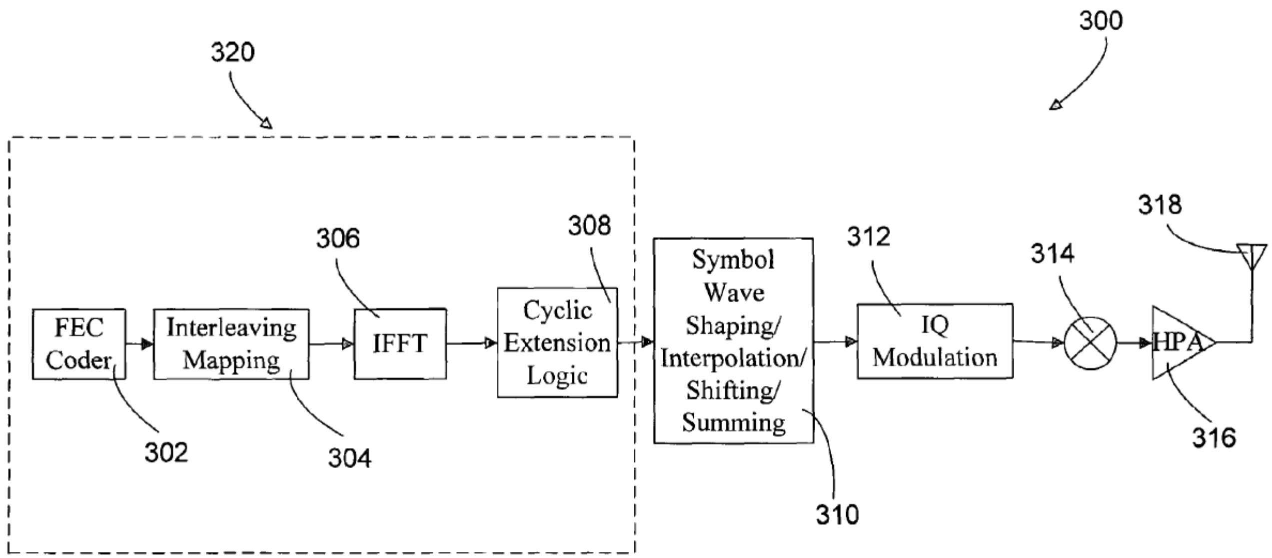
output, wherein the first up-converted signal comprises a first signal modulated at the first RF frequency and a second signal modulated at the second RF frequency; and	 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 (“802.11”) is set out in “Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications” and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate “dead spots,” and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See*, *e.g.*, Shearer at 8:17-9:24. For a system with “x” number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to “x.” In the shifting stage, the method is dependent on whether “x” is odd or even. If “x” is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See, e.g.*, Shearer at 9:25-54. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[24.4] a filter having an input coupled to the output of the first down-converter and the output of the second down-converter, and in accordance therewith, the filter receives the first and second down-converted signals.	Shearer discloses "a filter having an input coupled to the output of the first down-converter and the output of the second down-converter, and in accordance therewith, the filter receives the first and second down-converted signals." See, e.g.:

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	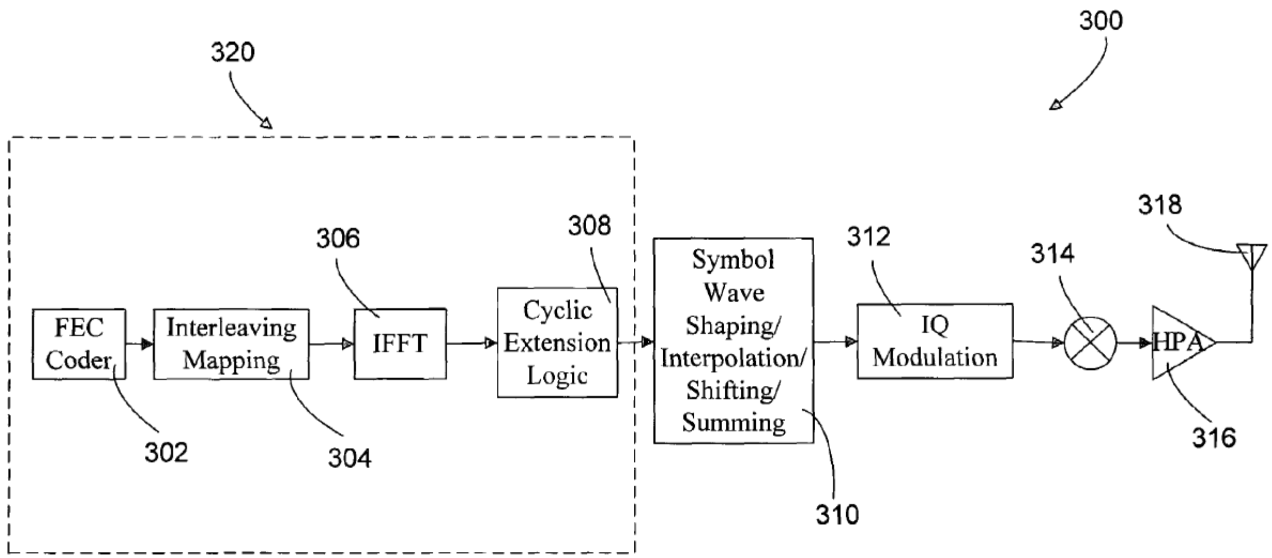 Figure 3 *See, e.g.*, Shearer at Figure 3. A wireless local area network (LAN) typically uses infrared (IR) or radio frequency (RF) communications channels to communicate between portable or mobile computer terminals and stationary access points or base stations. These access points are, in turn, connected by a wired or wireless communications channel to a network infrastructure which connects groups of access points together to form the LAN, including, optionally, one or more host computer systems. Wireless protocols such as Bluetooth and IEEE 802.11 support the logical interconnections of such portable roaming terminals having a variety of types of communication capabilities to host computers. The logical interconnections are based upon an infrastructure in which at least some of the terminals are capable of communicating with at least two of the access points when located within

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	a predetermined range, each terminal being normally associated, and in communication, with a single one of the access points. Based on the overall spatial layout, response time, and loading requirements of the network, different networking schemes and communication protocols have been designed so as to most efficiently regulate the communications. IEEE Standard 802.11 ("802.11") is set out in "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications" and is available from the IEEE Standards Department, Piscataway, N.J. 802.11 permits either IR or RF communications at 1 Mbps, 2 Mbps and higher data rates, a medium access technique similar to carrier sense multiple access/collision avoidance (CSMA/CA), a power-save mode for battery-operated mobile stations, seamless roaming in a full cellular network, high throughput operation, diverse antenna systems designed to eliminate "dead spots," and an easy interface to existing network infrastructures. The 802.11a standard defines data rates of 6, 12, 18, 24, 36 and 54 Mbps in the 5 GHz band. Demand for higher data rates may result in the need for devices that can communicate with each other at the higher rates, yet co-exist in the same WLAN environment or area without significant interference or interruption from each other, regardless of whether the higher data rate devices can communicate with the 802.11a devices. It may further be desired that high data rate devices be able to communicate with the 802.11a devices, such as at any of the standard 802.11a rates. *See, e.g.*, Shearer at 1:31-2:5. One embodiment of a transmitter for an 802.11 device is provided in FIG. 3. Referring to FIG. 3, a PHY unit 300 includes an orthogonal frequency division multiplex (OFDM) transmit kernel 320, a symbol wave shaper/interpolator/shifter/summer(accumulator, assimilator) 310, an IQ modulator 312, a mixer 314, high power amplifier (HPA) 316, and antenna 318. OFDM transmit kernel 320 includes an FEC coder 302 (for encoding the data received from a MAC unit), an interleaver/mapper 304, an inverse fast Fourier transform (IFFT) unit 306, and cyclic extension logic 308. During a data transmit process, data and control information are received at the FEC coder 302. The FEC coder 302 encodes data in a forward error correction code. Any forward error correction (FEC)

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	code can be used for this purpose. FEC code examples include a Reed-Solomon and a combination Reed-Solomon and convolution code, among others. The interleaver/mapper 304 subsequently interleaves (reorders, distributes) the encoded data. The output of the interleaver/mapper 304 is sent to the IFFT unit 306. The IFFT unit 306 receives input from the interleaver/mapper 304 and provides OFDM symbols to the cyclic extension logic 308. The cyclic extension logic 308 inserts a cyclic prefix (e.g., guard interval) to ensure that the transmitted symbol retains its orthogonal properties in the presence of multi-path delay spread. The output of the cyclic extension logic 308 is sent to the symbol wave shaper/interpolator/shifter/summer 310. Symbol wave shaper/interpolator/shifter/summer 310 comprises a low-pass filter to smooth the spectral edges between successive OFDM symbols. The trailing edge and leading edge of each OFDM symbol is tapered to prevent spectral splattering outside the frequency channel, minimizing adjacent interference and satisfying regulatory concerns. The symbol wave shaper/interpolator/shifter/summer 310 also comprises interpolation, shifting, and summing functionality as described below. *See, e.g.*, Shearer at 4:62-5:29. The output of symbol wave shaper/interpolator/shifter/summer 310 is sent to modulator 312. The modulator 312 modulates the encoded data onto carriers in OFDM symbols in accordance with conventional OFDM modulation techniques. The modulation techniques may be coherent or differential. The modulation mode or type may be Binary Phase Shift Keying and Quadrature Phase Shift Keying, among others. The output of the modulator 312 is sent to mixer 314 where it is upconverted to the desired transmit frequency. The upconversion may be performed in multiple mixer stages. From mixer 314, the upconverted signal is amplified in high powered amplifier (HPA) 316 and sent to antenna 318 for transmission. In an IEEE 802.11a/g design, each transmission channel has a bandwidth of 20 MHz. As shown in FIG. 4, in an IEEE 802.11a or IEEE 802.11g OFDM signal, a packet 400 within each 20 MHz channel has fifty-two (52) subcarriers. A first method of increasing the transmission data rate involves a variation in the waveform structure, or the subcarrier structure. In this section of the

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	discussion, the IEEE 802.11 a/g system will be referred to as an example legacy system. With IEEE 802.11a/g, as a nonlimiting example, there are sixty-four (64) subcarriers bins from −10 MHz 402 to +10 MHz 404 because a 64 point IFFT is used. However, only 52 of the bins are populated with non-zero subcarriers. Twenty-six (26) active subcarriers are spectrally less than zero (DC), and 26 active subcarriers are spectrally greater than zero. There are five unused subcarriers on each spectral edge, forming edge gaps at the −10 MHz 402 and +10 MHz 404 points. In this nonlimiting example, the packet is 20 MHz wide because that is the span of the 64 points in the IFFT. Also, the 20 MHz (wide) packets are spaced in channels whose center frequencies are separated by 20 MHz. In a 20 MHz packet, the active (populated) subcarriers span a spectrum somewhat less than 20 MHz wide, about 16.5 MHz, in this nonlimiting example. As provided in FIG. 5, to increase the data rate, the legacy waveform 400 is modified and then, as described in detail later, the data rate can be further increased by extrapolating to 40 MHz. The modification of the legacy packet 400 includes adding two sets 502, 504 of two subcarriers to each packet 400 for a total of four added subcarriers 502, 504. Note that, for simplification, all 52 subcarriers from the legacy waveform are not shown in FIG. 5. Also, although this discussion focuses on adding a total of four subcarriers, this disclosure should not be considered to be limited to a four-subcarrier addition. The four-subcarrier addition is an example used for simplification. The packet that had 52 subcarriers now has 56 subcarriers for each 20 MHz packet. A legacy packet uses 52 subcarriers; in the improved system, a packet uses 56 subcarriers. *See, e.g.*, Shearer at 5:30-6:12. To further increase the bandwidth of the signal, a processor (not shown) in the PHY 102 (FIG. 1) can further manipulate the OFDM signal. This discussion will focus on a scenario with two inputs, increasing the bandwidth by a factor of 2. However, the approach is applicable to any number of substantially simultaneous inputs. In one embodiment of an 802.11n system, two 20 MHz 802.11a input signals are received at the PHY unit 300 from FIG. 3 substantially simultaneously. The two signals are processed separately, one in a lower 20 MHz path and one in an upper 20 MHz path. A lower 20 MHz path 800 is presented in FIG. 8 and includes lower 20 MHz OFDM transmit kernel 320 a, interpolator 310 a, and −10 MHz frequency shifter 310 b. One of the inputs is first processed

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	by the lower 20 MHz OFDM transmit kernel 320 a which corresponds to the transmit kernel 320 from FIG. 3. The lower 20 MHz OFDM transmit kernel 320 a sends the signal to an interpolation stage 310 a where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 a corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The interpolation stage 310 a increases the sample rate of the signal. If the signal is interpolated by 2, the sample rate is doubled. Interpolation can be performed by inserting zeros (i.e. zero stuffing) between the original samples. Then, this zero-stuffed sample stream is low-pass filtered (e.g. in symbol shaper 310 of FIG. 3). The low-pass filter is designed so the original spectrum is maintained, and only the bandwidth is doubled. This zero-stuffed example is but one method of interpolation. Another method would be to duplicate each individual sample. Other methods known to one of ordinary skill in the art would also apply. The output of interpolation stage 310 a is then shifted down by 10 MHz at frequency shift stage 310 b. Frequency shift stage 310 b corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. FIG. 9 presents an exemplary 20 MHz 802.11a OFDM signal 900 centered at center frequency fc. Note that each individual subcarrier is not shown in each drawing. After being processed in the interpolation stage 310 a (FIG. 8) and the frequency shift stage 310 b, the resulting 40 MHz down-shifted signal 1000 is formed, as presented in FIG. 10. An upper 20 MHz path 1100 is presented in FIG. 11, and comprises upper 20 MHz OFDM transmit kernel 320 b, interpolator 310 c, and +10 MHz frequency shifter 310 d. One of the inputs is first processed by the upper 20 MHz OFDM transmit kernel 320 b which corresponds to the transmit kernel 320 from FIG. 3. The upper 20 MHz OFDM transmit kernel 320 b sends the signal to an interpolation stage 310 c where the signal is interpolated by a factor of the number of signals received substantially simultaneously. Interpolation stage 310 c corresponds to shaper/interpolator/shifter/summer 310 of FIG. 3. In this exemplary embodiment, two signals are received, so the interpolation factor is 2. The output of interpolation stage 310 c is then shifted up by 10 MHz at frequency shift stage 310 d. Frequency shift stage 310 d corresponds to

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	shaper/interpolator/shifter 310 of FIG. 3. The frequency shift is performed by multiplying the sample by ej2Πf shift t, where fshift is the amount of desired frequency shift. An exemplary 20 MHz 802.11a OFDM signal 900 (as provided in FIG. 9), centered at center frequency fc, is processed in the interpolation stage 310 c and the frequency shift stage 310 d. The resulting 40 MHz up-shifted signal 1200 is formed, as presented in FIG. 12. FIG. 13 presents an exemplary embodiment with 2 signal paths, upper path 1100 and lower path 800, each processing a 20 MHz 802.11a input signal substantially simultaneously. The output of each path is aggregated in adder 310 e to achieve, in this exemplary embodiment, a signal 1400 with a 40 MHz bandwidth and a 40 MHz sample rate as shown in FIG. 14. As provided above, this process could be easily adapted for other systems with different protocols, with different frequencies, and with more input signals. *See, e.g.*, Shearer at 8:17-9:24. For a system with "x" number of input signals with substantially similar bandwidths and center frequencies, received substantially simultaneously, the interpolation stage is performed by interpolating by a factor equal to "x." In the shifting stage, the method is dependent on whether "x" is odd or even. If "x" is even, each signal is shifted from the center frequency by a succeeding multiple of the bandwidth (BW) of the signal. For example, as illustrated in FIG. 15, if six 10 MHz signals (A, B, C, D, E, and F) are received, each is interpolated by a factor of six (6) in blocks 1500 a-1500 f. Each signal with a 10 MHz sample rate is interpolated such that each has a revised sample rate of 60 MHz. Then, in block 1502, signal A is shifted up by the BW/2. In block 1504, signal B is shifted down by BW/2. In block 1506, signal C is shifted up by 3*BW/2. In block 1508, signal D is shifted down by 3*BW/2. In block 1510, signal E is shifted up by 5*BW/2. In block 1512, signal F is shifted down by 5*BW/2. In block 1514, the six shifted signals are aggregated into one composite signal for transmission. This process is applicable for any even number of input signals. Each simultaneous

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	input is interpolated and shifted from the center frequency by a progressive odd multiple of BW/2 on alternating sides of the center frequency. FIG. 16 demonstrates how an even number of signals are distributed from the center frequency. Signal A 1602 is shifted up by BW/2, signal B 1604 is shifted down by BW/2, signal C 1606 is shifted up by 3*BW/2, signal D 1608 is shifted down by 3*BW/2, signal E 1610 is shifted up by 5*BW/2, and signal F 1612 is shifted down by 5*BW/2. *See*, *e.g.*, Shearer at 9:25-54. Furthermore, this claim element is obvious in light of Shearer itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.